RESEARCH AND DEVELOPMENT

(Part 2—Military Research Representatives)

UNIVERSITY OF MICHIGAN
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MAIN READING ROOM

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON GOVERNMENT OPERATIONS HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

SECOND SESSION

JULY 14, 15, 17, AND 18, 1958

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RESEARCH AND DEVELOPMENT

(Part 2—Military Research Representatives)

MONDAY, JULY 14, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION,
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., in room 1501, New House Office Building, Hon. William L. Dawson (chairman) presiding.

Present: Representatives Dawson, Harden, Brown, and Michel.

Also present: Orville S. Poland, general counsel; James A. Lanigan, associate general counsel; Milton G. Johnson, professional staff assistant; Elmer W. Henderson, subcommittee counsel; and William A. Young, staff consultant.

Chairman DAWSON. The subcommittee will come to order.

The 4 days of testimony we are commencing today are a second phase of the hearings on certain aspects of the scientific research and development activities of the Federal Government which we began on January 15, 1958.

The first phase consisted of background testimony given by a number of outstanding men in the field. Their testimony has been printed in hearings entitled "Research and Development (pt. 1, Background Testimony)." Copies may be obtained from the committee on request.

Today, and on Tuesday, Thursday and Friday, we are going to devote 1 day to each of the 4 top civilian officials concerned with research and development in the Department of Defense.

We have asked them to be prepared to discuss extemporaneously their views and observations on the items listed on the sheet entitled, "Outline of Subjects for Discussion at Hearings July 14–18, 1958."

These subjects all involve the efficiency and economy with which research and development operations are conducted, or budgeting and accounting for research and development, all of which are within the scope of the committee's statutory duties.

We realize that legislation is now pending to reorganize the Department of Defense. However, the legislative proposals would give to a director of research and engineering in the Office of the Secretary of Defense great authority and wide latitude in reorganizing the structure and procedures through which the Department of Defense and its component departments conduct scientific research and development.

Consequently the lessons to be learned from experience and from the existing organization and operations should be very valuable to those

who will be responsible for putting the reorganization into effect and to those Members of Congress who will be responsible for evaluating its results.

We will hear today from the Assistant Secretary of the Navy for Air, Mr. Garrison Norton.

You know Mr. Brown, do you, Mr. Norton?

Mr. Brown, this is Mr. Norton, Assistant Secretary of Navy.

Mr. NORTON. Mr. W. W. Edwards, who is with me, is the Comptroller of the Office of Naval Research.

Chairman DAWSON. Mr. Edwards.

Mrs. Harden, this is Mr. Norton and Mr. Edwards.

Before you begin, I would like to introduce for the record the outline of subjects for discussion at the hearing of July 14–18, 1958.

OUTLINE OF SUBJECTS FOR DISCUSSION AT HEARINGS JULY 14–18, 1958

I. Effect of (*a*) year-to-year changes in moneys appropriated, (*b*) rising costs, (*c*) increased complexity of weapons, and (*d*) expenditure limitations on the ability of the military services to carry on research and development programs which they believe the Nation's security requires.

II. Problems of budgeting and accounting which adversely affect research and development operations.

III. Fiscal, organizational, and operational problems arising from the centralization of control and detailed direction of research and development, including those arising in the relationships between the military services and the Office of the Secretary of Defense.

IV. Problems arising from the policy of a fixed dollar level for research and development in a time of rising prices and increased weapons complexity.

V. Utilization of the results of basic research in weapon development.

VI. Problems involved in retaining competent personnel.

VII. Areas in research and development where efforts should be concentrated to minimize serious waste of funds through duplication, unwise development, and other causes.

VIII. Nature and results of research and development work performed overseas.

IX. Effect of military requirements on scope of research and development.

X. Lessons to be learned from conduct of industrial and other research.

STATEMENT OF HON. GARRISON NORTON, ASSISTANT SECRETARY OF THE NAVY FOR AIR; ACCOMPANIED BY COMDR. JOHN LAW, USN, OFFICE OF ASSISTANT CHIEF OF NAVAL OPERATIONS FOR RESEARCH AND DEVELOPMENT; AND WILLIAM W. EDWARDS, COMPTROLLER, OFFICE OF NAVAL RESEARCH

Mr. NORTON. I received, of course, your letter of July 9, and in that letter you said:

> It is believed that the committee's purpose would be served by an extemporaneous discussion of your views and operations on the items listed.

Possibly the list would not be required, but it is a subject list of the items.

Just before this hearing began, I understood that it would be agreeable with you if I started in order with the 10 questions as you listed them in your letter.

I also suggested to you, sir, and you said it was agreeable, that Mr. Edwards sit with me, and if the committee wishes to get into details of the impact of budgeting and fiscal controls on the research effort of the Navy, Mr. Edwards, who is the Comptroller of the Office of Naval

Research, could speak in detail to those points and specifically with respect to your question No. 2. I would like, after making some general comments, to refer that question to Mr. Edwards, if I may.

Mr. BROWN. Mr. Chairman, before the witness begins, I wonder if it would be helpful to both the witness and the committee, if the witness, as he completes his statements on each of the numbered paragraphs, answer questions at that time, rather than wait until we get clear through to go back and try to pick up our line of thought.

Chairman DAWSON. We will try that.

Mr. NORTON. I think that is a good suggestion, Mr. Chairman.

In line with that, I would suggest that you let me put items No. 1 and No. 4 together for the purpose of discussion, because a great many of the points that come up under No. 1 also apply to No. 4. As a matter of fact, the two are very closely allied.

I think, perhaps, if I discuss those two together, first, and then pause for questions, it would expedite it.

Chairman DAWSON. Congressman Michel, this is Mr. Norton, Assistant Secretary of the Navy, and Mr. Edwards.

Mr. NORTON. My name is Garrison Norton. I am Assistant Secretary of the Navy for Air. My duties also include the administrative supervision of Research and Development of the Navy, which actually occupies, by far, the larger part of my time.

The first question is the effect of (*a*) year-to-year changes in moneys appropriated, (*b*) rising costs, (*c*) increased complexity of weapons, and (*d*) expenditure limitations on the ability of the military services to carry on research and development programs which they believe the Nation's security requires.

Question No. 4, which is so closely related to this, is:

Problems arising from the policy of a fixed dollar level for research and development in a time of rising prices and increased weapons complexity.

Mr. Chairman, I believe your very able staff, which has been working for some time with all three services, has furnished you with all the numbers in this matter.

I have with me charts and statistics showing the year-to-year moneys appropriated, and unless you wish me to repeat that information, I will go on to the item (*b*) here, rising cost, and assume that you have the figures that you want.

If there is any question about that, I would be very glad to give you what I have here in the way of charts and detailed information.

Mr. BROWN. Mr. Chairman, before Mr. Norton gives us that information, I wonder if he would tell us, just for our background information, the amount of moneys previously appropriated that you have obligated to carry over July 1?

Mr. NORTON. Which year, Mr. Brown?

Mr. BROWN. 1958 into fiscal 1959.

Mr. NORTON. Fiscal 1959. I do know this, that we have obligated a very high percentage of it, but I would like Mr. Edwards to give you the answer to that because he knows it.

Mr. EDWARDS. The exact figure is not known just yet, but the advanced estimate that I was looking at early this morning is approximately $26 million.

Mr. BROWN. How much obligated will you carry over?

Mr. EDWARDS. Again, we are carrying over an obligated balance of between $300 million and $350 million a year.

Mr. BROWN. When were those obligations made; during June or over the year?

Mr. EDWARDS. This year of 1958 has been a very unusual year. Normally they would run over the entire year. This year there have been supplemental appropriations made available that would make the obligation in the last few months of the year higher than average.

Mr. BROWN. We have had the experience in the past of looking at the Government buildings lighted up at night, with people on overtime, trying to get the appropriations spent before the end of the year. I just wondered if that policy is followed in your department this year?

Mr. EDWARDS. It is not a matter of policy, Mr. Brown. One cannot start obligating money until after the appropriation is made. Then you have the normal amount of time to do it, particularly in research and development where you have rather complicated contract negotiations that have to go on. You just go on and do them day by day as you get a chance, the best you can.

As a matter of experience in the past, you will find that the rate of obligation does become higher in the last 6 months of the year.

Mr. BROWN. What about the last 15 days of the fiscal year? Did you have any appreciable increase in the obligations made during that last 15 days?

Mr. EDWARDS. This year? Yes.

Mr. BROWN. How much? What percentage? What did they obligate out of this two-hundred-some million or three-hundred-and-some million?

Mr. NORTON. We are talking here of the total research and development for fiscal 1958. A figure of $589 million. The $26 million carryover that Mr. Edwards mentioned——

Mr. BROWN. That is unobligated.

Mr. NORTON. You can see is a very small fraction of the total.

Mr. BROWN. But you said they carried over obligated funds of about what, three hundred——

Mr. EDWARDS. The unliquidated obligations for the year, somewhere between 300 and 350.

Mr. BROWN. What percentage or amount of the $350 million for the year was obligated during the last 15 days of June, which was the end of the fiscal year?

Mr. EDWARDS. If you will permit me to get the accurate figure later——

Mr. BROWN. Give us an estimate now, so that we will have a basis on which to build. It has been a practice that has gone on in the Government for a good while. It is reprehensible, in my opinion, and should be stopped, that is the practice of obligating everything you possibly can at the end of the fiscal year, so that there won't be much in unobligated funds, or only a small amount of unobligated funds, to carry over.

Mr. EDWARDS. I would like to make two points, in the first place we have a no-year appropriation, and we don't have to obligate at the end of the year unless there is a reason for doing it. It can be carried over and used in the next year as well.

From memory, the second thing, I would say in the last 15 days of June, the obligation probably approached $35 million. I am basing this on the fact that about $80 million had to be obligated in June or was available for obligation and just assuming half and half, it would be roughly $30 million, $35 million.

Mr. BROWN. It is not too far out of line in comparison with the timelag. Thank you very much.

Mr. NORTON. Now, we come to (*b*), the effect of rising costs.

I might make one general statement, with respect to (*a*), before I leave it, Mr. Chairman. In research, the effect of year to year changes in money appropriated is particularly disruptive. The basic reason for that is that money appropriated for research is appropriated primarily to pay people. Only a small percentage goes to the placement for purchasing necessary equipment, which allows you to do new and more advanced research.

Of course, competent scientific people are difficult to find, and since it is absolutely essential that you hold a good research team intact, if you are going to do a good research job, there is tremendous pressure on management to hold your team together, and if you have to, to do this at the expense of equipment, if you are short of money.

Over the past several years, although the dollars available out of our total appropriation have been as constant as we could keep them, the purchasing power has gone down.

As a result of that, we have been very hard put to purchase new equipment. This, of course, is at a time when we all knew—I am not talking just since sputnik, I am talking the past several years, when we all knew of the gigantic Russian effort in this field and the tremendous amount of money that they were pouring into all kinds of items, equipment, education, and good salaries for their scientists.

Just to give you perhaps some feeling of what I am talking about, immediately after sputnik, the Navy received $15 million in supplemental funds for basic research.

Here are some of the examples, just a few examples of the equipment that this relatively modest sum, that we got after sputnik, enabled us to purchase.

I have listed them here. We allowed $140,000 to the University of California for radio star astrophysics.

We had already been providing funds for the design and acquisition of an 85-foot diameter parabolic reflector antenna.

These additional funds will provide for the erection and installation of the antenna and for the related instrumentation.

The university will then have a complete facility, which, after critical testing, will permit intensified study of the characteristics of gaseous clouds surrounding extra galactic radio sources.

Thirty-five thousand dollars to the University of Colorado. This had to do with their high-altitude observatory. This provide funds to begin the construction of instruments.

I won't go into detail there, but it gives them some essential hardware which they need to carry on their work.

Stanford University, $7,500, basic electronics research.

Another one at Stanford University, $124,000, structures for ultraspeed to provide for the construction of a wind tunnel which appears most suitable for the investigation of the surface when exposed to hypersonic flow.

Harvard University, $65.000, high pressure. To purchase a Perkin-Elmer infrared spectrometer and a Varian magnet, both now on loan from the Lincoln Laboratory, and to purchase special high-pressure microwave components for studies of resonance of garnets and ferrites. This has to do with high pressure.

Alfred University, $1,070, semiconductor research.

Yale University, $50,000, atomic resonances. To purchase an atomic clock to enable measurements of higher precision.

George Washington University, $100,000, logistics computer service. To provide for needed modifications to the logistics computer and for needed modernization of equipment.

University of Pittsburgh, $16,000, charge exchange to allow construction of an atomic beams apparatus for low-energy proton scattering.

Cornell University, $300,000, photon-meson reactions. To enable the contractor to install an improved injector and so forth.

These are just items of hardware on which we have been skimping. We have had to in the past in order to maintain as even a level as we could for basic research in terms of people, as well as in terms of equipment.

Mr. BROWN. May I ask a question, Mr. Chairman?

Chairman DAWSON. Yes.

Mr. BROWN. What percentage or what proportion of the funds expended by your agency for research and development equipment went to colleges and universities? What percentage or proportion went to private industry, and what percentage or portion—that is, roughly speaking—went to installations within the Navy itself?

Mr. NORTON. I don't know whether Mr. Edwards can come up with that figure.

Mr. EDWARDS. Out of the entire appropriation for, say, 1957—1958 not being completed yet—I would say something just over half would go into industrials, universities, and so on, and the percentage of just under half, perhaps around 48 percent, was used by the Navy in the Navy's own laboratories.

The figures I can recall are roughly $242 million as the cost of running the Navy's laboratories, as opposed to $257 million as the cost of contractual research and development.

Mr. BROWN. Then, most of your research and development is actually done by colleges, universities, or by private industry?

Mr. NORTON. In our case, slightly more than 52 percent is done by colleges and by industry.

Is that correct?

Mr. EDWARDS. Yes, as long as you add industry to it.

Mr. BROWN. How is it divided between colleges and universities?

Mr. EDWARDS. In 1957 about $32 million in universities and $225 million in industry.

In these discussions this morning, one has to be careful to differentiate between research and development, because, for instance, the universities do not do any development. They confine themselves to research, whereas the industries are almost exclusively development work.

Mr. NORTON. In that connection, Mr. Chairman, I might mention here for the record that it is the Navy's policy now and has been,

certainly since I have had this job, to devote as large a percentage as possible of our research and development dollar to what we call basic and supporting research as contrasted with work in connection with the development of approved weapon system.

This actually works out at approximately a 50–50 division and our budget is prepared on the basis of two categories. One category lists in order of priority the research and development associated with approved weapon systems. The other category lists—not in order of priority, because you can't establish priorities on basic research—lists the items of basic and supporting research.

Now, as I say, this is about a 50–50 split between those two categories.

I think that is an important percentage to bear in mind, because there seems to be a general impression, Mr. Chairman, that the services are inclined to skimp on basic research support in favor of weapon systems.

If you look back into the history of this, that is true. That has been the case, certainly in the early stages of World War II, when the importance of research was first really recognized at the Presidential level, you might say. It was true, I think, that all three services tended to dominate research and guide it in the direction of specific weapons that they were interested in. But this is past history now, some years past.

The Navy has been a leader in the support of basic research. In fact, there was a period, a long period after World War II, when the Navy, through the Office of Naval Research, was the only Government agency outside of the Atomic Energy Commission directly supporting a large effort in basic research.

The next item under No. 1 is (*c*), increased complexity of weapons.

I thought I might just give you some examples of what has happened during this 12-to-15-year period, which has resulted in fantastic increases in cost and complexity of weapons.

Fundamentally, of course, looking at it from the Navy's point of view—incidentally, Mr. Chairman, I spent 5 years as a consultant to the Secretary of the Air Force in this same field just prior to my present assignment, and so I spent 5 years looking at it from the Air Force's point of view. In general, it is the same story for the services.

In looking at it from the Navy's point of view, the Navy, of course, is making and has been making the transition from fuel oil to nuclear power. We have been making the transition from high-explosive bombs to thermonuclear weapons.

We have been shifting from guns and shells and bullets to guided missiles of all kinds and descriptions.

We have been shifting from so-called conventional airplanes, piston airplanes with a maximum speed of 400 knots, to jet airplanes with speeds of over 1,000 knots.

Now, of course, we do get vastly more potent and versatile weapons, but the dollar cost of these weapons goes up at a simply fantastic rate.

Since 1946, for example, labor costs have gone up 66 percent, material costs have gone up 125 percent. We have had a total cost increase, over which we have no control, of over 190 percent.

Here are a few examples of cost increases of naval weapons. Some submarines now cost 8 times as much as the World War II submarines.

AIRCRAFT

Modern attack bomber, up to 100 times the cost of a World War II attack plane.

In 1940, for example, a so-called SBD that I used to fly in the Navy Reserve and am very familiar with, used to cost $125,000 a copy.

In 1949, the AD, which is still in the fleet today—it is a single-engine plane and has fantastic lift capability—that single-engine AD is the honored, retired, old work horse of the fleet today. It is about to be replaced by a jet engined airplane. It will lift a bigger load than the four-engine Flying Fortress of World War II. It cost $200,000 a copy and replaced the SBD, of $125,000.

We are now replacing the AD with A3D's. That is an airplane that cost $2,300,000 a copy. It is, of course, a jet-propelled aircraft, with a very sophisticated fire-control and bomb-dropping system and long range.

These A3D's are the airplanes that have crossed the continent nonstop, taking off from one carrier on the Pacific side and landing on another carrier on the Atlantic side.

Component and equipment costs are up in proportion to all of this. From guns to missiles, for example, on a World War II destroyer compared with guided missile destroyer equipment, there is a cost increase of 850 percent for ordnance.

When it comes to fighter airplane electronic equipment improvements, you might summarize a comparison with the expression "from eyeballs to electronics," there is a cost increase of 116 percent for electronic equipment of a modern fighter over that of a World War II fighter.

Of course, nuclear power involves all of these nuclear powerplants that are going into ships. I don't mention a percentage there because the development is so rapid in the nuclear power area that it is a little misleading to quote figures now, but they are very high indeed compared with traditional oil-burning equipment.

You can say that, overall, an oil-fired powerplant compared with a nuclear powerplant represents a cost increase of about 600 percent today.

World War II piston-engines for aircraft, compared with jet engines, on the average the cost increase is about 1,000 percent.

On top of all of this, or a part of it, really, is the complexity. Each time you make a forward step in performance and capability of weapons, you get a jump in technological complexity of the weapon.

This adds not only to the initial dollar investment, but also the costs of keeping it in operation, as well as the difficulty of keeping it in operation and the caliber and training of the people that you have to have to keep these things flying.

I can give you some feeling for this in a rather direct measurement, namely, the maintenance man-hours required to keep an airplane in the air, since modern military airplanes encompass the technological improvements in ordnance, electronics, propulsion. Compared with World War II airplanes, the present airplanes have shown a 4-to-1

increase in complexity, which is demonstrated in these representative figures of maintenance man-hours per flight hour.

The World War II F6F, which was really the standard fighter of the fleet during most of the war, required 11 man-hours of maintenance per flight hour.

The F8F, which was the last of the piston-engine fighters that came into the field shortly after the war was over, 12 hours.

The F9F, which was one of the earlier jet fighters, 19 hours.

The F11F, which is—these 4 that I have given you so far are all Grumman airplanes, and I have picked them deliberately to list the same company and same field for that.

The F11F, which is a supersonic, very high performance fighter, 31 hours.

The F4D, that is a small carrier based all-weather fighter, 38 man-hours per hour of flight time.

The F8U–1, which is our present fleet fighter, 38 man-hours.

The F4H, or the F8U–3, whichever one you choose, this is the new very high performance fighter which has come along. Both of them are now flying competively out of Edwards Airbase. It is estimated at more than 40 maintenance man-hours.

I could go on a long time, Mr. Chairman, with that kind of illustration, but that is what has happened to us in this, that comes under the heading of your question No. 1 (*c*).

Under 1 (*d*), the effect of expenditure limitations on the ability of the military services to carry on research and development programs which they believe the Nation's security requires. It is rather difficult to convey the full implications of the imposition of an expenditure limitation on the research and development program without getting rather deeply into Government financial technique and policy.

I want to make it clear here, Mr. Chairman, that I am not implying any criticism of any individual in the system of Government financial policy and technique. The people with whom I have been dealing, like former Director of the Budget, Mr. Brundage, and his successor, Mr. Stan, or Mr. McNeil, the Comptroller of the Department of Defense, I found them all to be fine, hard-working people who were trying to carry out their orders as best they can under the existing policy.

Furthermore, I don't set myself up for 1 minute as being capable of evaluating this policy. If the President of the United States and the Secretary of the Treasury and the Secretary of Defense feel that a certain percentage, say 10 percent of the gross national product of the United States, is all we can and should put into the defense program, I don't consider myself in a position to question that.

I may have my own views as a private citizen, as to the extent of the effort that this country should put into defense, but as a member of the team here, I am perfectly willing, and always have been, to abide by that decision and to, furthermore, abide by the decision of the Secretary of Defense when it comes to dividing up the dollars among the three services, and this gets you down to the Navy's total.

At that point, of course, I have a selfish interest in getting as large a percentage of that Navy total as I can for research and development. I personally feel it should be a very high percentage. I think

the taxpayer's dollar that is invested in research and development is better invested, in many cases, than in specific items of hardware. Furthermore, I know that the items of hardware is where the money really goes in large amounts, so I begrudge every penny that I have to give up when I sit around the conference table in the Navy Department and try to fit my programs for research into the Navy's straitjacket for dollars that are assigned to it by the Secretary of Defense.

However, there does come a point in this painful process when I have to think about the whole Navy. I am thinking of Arleigh Burke's problem as Chief of Naval Operations. I know we have to have ships at sea, planes flying; we have to have gasoline to fly them and train the boys to fly them. We have an antisubmarine program, and the whole problem of controlling the seas. From Arleigh Burke's point of view—and he is as much interested in research as I am, there is also the problem of running the fleet and keeping it in being—and so I find myself in the end agreeing to a reduction in the research and development dollar that the Navy is going to ask for, something that I personally don't believe in, but am prepared to go along with, knowing as I do what the total problem is for the Navy.

The same is true, of course, for the Air Force. I had to go through very much the same process in the Air Force when I was there.

From the standpoint of administration of expenditure limitations it should be pointed out in the first place that research and development funds are used for two major purposes. First, you have to finance research and development directly in the Navy's laboratories. This includes, of course, the salaries you pay, the travel of people, supplies, equipment, heat, light and power, and so forth. That is the direct support.

The Navy has historically been the technical service that has operated and maintained more laboratories, more in-house laboratories than any of the other services.

The second major point, you have to finance research and development indirectly through contracts with universities and through certain nonprofit organizations and, of course, with commercial and industrial concerns.

Now, it is not often realized that, in terms of actual expenditure of funds, each of those two purposes results in an expenditure pattern that is peculiar to itself and quite different from the other one.

For example, 87 percent of the funds appropriated for direct use by Navy research and development facilities results in actual expenditures in the year appropriated. The balance, which represents supplies and materials equipment and sometimes payrolls, is paid in the second year. This carryover amount must be covered by the succeeding year's expenditures limitation—I am talking about this straitjacket—and obviously cannot be easily changed to reduce its expenditures.

In the case of the other half of the business, the contractual part of it, the pattern is considerably different. If one keeps in mind that contracts cannot all be executed on the first day of the year, but they are executed day in and day out throughout the year, as Mr. Edwards mentioned here, it is easy to understand why only 34 percent of the funds appropriated for contractual research and development is actually expended in the year it was appropriated, some 56 percent in the second year and the balance in the third and fourth years.

This carryover, 66 percent of the end of the first year, must also be covered by succeeding years' expenditure limitations. Since this is the pattern the expenditure in research and development actually follows; namely, an aggregate of 53 percent is spent during the first year of availability, $47 out of every $100 expended during the year is the result of the prior year's work on Navy laboratories or contracts. That is putting the two things together and striking an average.

Therefore, in fiscal 1959, the Navy's research and development program managers know that almost half of the research and development expenditures during the year will be the result of the latter year's program. If they receive an expenditure limitation for fiscal 1959 equal to or greater than the estimated expenditures for that year, they are in no trouble. In other words, if the straitjacket is that big, we are all in. However, if the limitation is lower than the estimated expenditure, we are in real trouble, since it is obvious that the funds appropriated for fiscal 1959 could not be used as planned. Our managers then—and this is Mr. Edwards' problem—would have only two real choices; either to cut back the planned support of the Navy research and development centers or cut down on contract research.

Assuming a required reduction in expenditures of $34 million for the year, then almost $38 million in planned support of the Navy's laboratories would have to be withheld. This would be more than the 15 percent cut in such support and would involve major reductions in the scientific and technical personnel in those laboratories.

If the choice was to absorb the reduction in new contract work, then approximately 100 million new contractual research could not be started.

In actual practice, it could be a combination of both, of course.

What I am trying to make clear here, Mr. Chairman, is that effective expenditure control in this business is a matter of timing. If we have to be controlled, it should be very carefully timed.

For example, if, as of this date, it was necessary to reduce levels of expenditure and at the same time to prevent any unnecessary damage to the programs that we are interested in, the target day for achieving this action successfully should be set for the fiscal year 1960. The desired ceiling for fiscal year 1960 would have to be set before the funds for fiscal year 1959 were obligated.

At this time we don't even know the expenditure limitation for fiscal year 1959.

I don't know how soon we are going to know, do you, Mr. Edwards?

Mr. EDWARDS. We have hopes of knowing it any day now.

Mr. BROWN. You are operating now under the 1958 limitations?

Mr. EDWARDS. No, we are operating under a tentative figure, just a sort of talking figure for 1959.

Mr. BROWN. Congress adopted a joint resolution extending into 1959 the spending rate of all agencies and Government departments, for which Government appropriations had not been made for 1959, at the same rate as 1958?

Mr. EDWARDS. That is correct, except that that controls obligation of money, and Mr. Norton has been talking exclusively of expenditure of funds or withdrawals from the Treasury. It is an entirely different process.

Mr. BROWN. I thought it applied to both expenditures and contractual relations, expended at the same rate or contracted at the same rate.

Mr. EDWARDS. We are allowed to obligate our money at the same rate we had in the previous year and also we are not to start new projects that are under discussion by the Congress. In other words, we will continue to work as——

Mr. BROWN. They were not authorized and appropriated for under the 1958 budget?

Mr. EDWARDS. That is right. Anything new in the 1959 budget that has not been passed on, we don't start.

Mr. BROWN. I understand that.

Mr. EDWARDS. But in continuing the past year's program, it is an authority to obligate money, as I understand it, which carries with it at least implied orders that one continue to pay the bills as they come due, the actual withdrawals from the Treasury.

Mr. BROWN. That is what appropriations are for, to furnish the money in the end. Obligations just means something you are going to have to pay for later.

Mr. EDWARDS. The separate limitations on expenditures or withdrawals from the Treasury, which Mr. Norton is talking about, is over and above obligation control. It is a different breed of cat, because it has a different set of patterns and experiences and rules that govern it.

Mr. LANIGAN. Perhaps Mr. Norton can tell us the effect of the expenditures controls since he has been in his present position.

Secretary NORTON. I can.

This brings me to question No. 2.

May I suggest, since the chairman is agreeable to it——

Mr. BROWN. Before you go to No. 2, may I ask one specific question?

Chairman DAWSON. Yes.

Secretary NORTON. I was going to suggest we go to No. 4, which is very closely allied to No. 1.

Mr. BROWN. I wanted to ask you about (*d*). You gave us some very good and perhaps some very startling examples in the increase of cost for different types of fighting equipment, planes, and so forth, which, of course, as I understand it, are supposed to be the end result of research and development. Otherwise, we don't need research and development unless we are going to develop new fighting equipment, new weapons, new means of defending the United States, and perhaps carrying the war to enemies overseas, if we have such.

You mentioned a great increase, but you didn't mention an increase in the effectiveness of these weapons.

Secretary NORTON. It is a little hard to measure.

Mr. BROWN. In other words, if the cost is up 800 percent, is the effectiveness up 800 percent or 500 percent?

Secretary NORTON. I hinted, Mr. Brown, that the cost is up to such an astronomical degree that it is a little hard to visualize in all cases the effectiveness being up that much.

Yet, when you consider the fact that one A3D in one attack can carry and deliver a greater explosive force than all of the chemical explosive weapons used in World War II, you are saying quite an interesting thing.

Mr. BROWN. You are getting right around to the point and the question I have in my mind, and that is: While it costs a great deal more for these new weapons of war, those new planes—for instance, a single one, carrying as much explosives in the way of bombs as all the various bombers in World War II—doesn't that reduce the need for the number?

Secretary NORTON. It does, indeed, and the Navy's planes——

Mr. BROWN. You can't figure the need on the basis of the number of planes we had in World War II.

Secretary NORTON. No relation, no relation.

Mr. BROWN. And the weapons actually developed are less in number?

Secretary NORTON. Indeed, they are.

Mr. BROWN. That is a very important thing, Mr. Chairman.

Secretary NORTON. You might say that the standard number of airplanes that the Navy has had, as the Navy's air arm over a longer period of years, has been 10,000 aircraft of all types.

Mr. BROWN. What percentage of that would be combat types, of the 10,000 in the past?

Secretary NORTON. Fifty percent. That would be 5,000 combat. Today's number of combat types that are under procurement from the Bureau of Aeronautics are less than 1,000 a year.

Mr. BROWN. And that reduces in about the same ratio the need. While you have a greater increase in the need for manpower for each plane, you would have a lesser number of planes to take care of and to service?

Secretary NORTON. That is right, Mr. Brown. It is a change. It isn't always a reduction in the numbers of people, partly because of this maintenance problem, but it is a change. It is a change in the training program. They don't have to turn out the same number of pilots, but the pilots you do turn turn out almost have to be Ph. D.'s as well as good fliers.

The same is true of your maintenance people.

Mr. BROWN. Let me ask you one other question. Mr. Chairman, I beg your pardon for interfering. We get the story from sources both within and without the Department of Defense that some foreign countries have very effective planes which do not carry all of the intricate instruments and all of the extra facilities, and so forth and so on, that the American planes carry, of the same type and class, that are built and designed for the same purpose.

Have we gone too far in this attempt, in our research and development, in making certain that we not only have an effective fighting equipment, but we, also, have a Cadillac style instead of the Ford style?

Secretary NORTON. There is always a danger of that, Mr. Brown. It is a natural thing to do, we have a feeling in this country, when we send a boy into battle, that we want him to have the best equipment, the best firepower that he can have.

Mr. BROWN. I understand that, and I agree with it, and have heard the same argument a good many times, but if a boy goes into battle, I am not so sure that he is so much interested as to whether he has 8 inches of foam rubber on the seat he sits on or only 4 inches of foam rubber, as in having a good plane. What he is interested in is

having an effective plane, and good weapons to use, to best protect his life. He can get killed in a plush outfit as easily as in one that is more utilitarian.

Secretary NORTON. It is a question of where you draw the line. There are technical experts at the Bureau of Aeronautics, that is why they are there, who are trying to improve these weapons all the time. If they see some way of increasing the firepower, accuracy, or range or speed of that plane, they immediately come rushing enthusiastically forward with it. It is a matter of judgment every time.

I think, though, that that picture has been somewhat exaggerated. After all, we know from direct combat as well as intelligence sources that the Russians are producing magnificent airplanes.

The fact that the F–86's could down the MIG's in the Korean war was due, in part, to, I think, the extra training that our pilots had. I think they were better flyers.

It was due, in part, to this Cadillac element that you mentioned. The Russians have produced new aircraft at a rapid rate with tremendous advances in technical capabilities since the Korean days and all I can say is that we are hard put to it to match what we know is the Russian capability in the air today.

We feel that we have done so. We feel that our fighters can take care of their fighters, in this new generation, just as the F–86 took care of the MIG.

Mr. BROWN. I hope I have made my position clear. There is no one, certainly not I, myself, who wants to hold down on any expenditure that will give any American boy better, more efficient, and more effective fighting equipment, whether it be a plane or a gun.

However, I am not unfamiliar with the fact that the automobile industry always tries to sell every patron all the extra appliances and equipment they possibly can, whether it is actually utilitarian or not.

Secretary NORTON. You are quite right.

Mr. BROWN. I rather speak from my own knowledge that there might possibly be 1 or 2 airplane manufacturers in the United States who have the same idea. If they can figure out some new thing to put on a plane, whether it is of any real benefit or not, as far as actual fighting is concerned, or actual defense and survival is concerned, if they can sell a new piece of equipment, they are perfectly willing to do so, especially if they are on a cost-plus basis, as we have seen so often.

Secretary NORTON. It is something we have to watch and we do watch.

Mr. BROWN. And you do watch that very carefully. I think it is important, Mr. Chairman, to bring that out in consideration of this.

Mr. LANIGAN. Does the fact that we have to produce fewer of any particular type weapon in order to secure greater firepower mean that we have to do less research, or do we have to do more research?

Secretary NORTON. It means we have to do more, every time.

Mr. LANIGAN. Why is that?

Secretary NORTON. Well, it is just due to the complexity of the weapon. Every time you move forward now on the curve of speed, for example, of manned aircraft by a small fraction of a Mach number, you move into fantastic new costs and you move into fantastic new research problems. As long as our potential enemy—as far as I am

concerned you can leave out the word "potential"—is doing just that, there isn't any alternative for us. We have to get in there and do the same thing. This means more research.

Mr. LANIGAN. The figures the Navy Department has supplied indicate that the amounts requested and appropriated for research after surging up during the time of the Korean war—this is the Navy—around $498 million, then drop down to, in 1955 and 1956, to $389 and then went back to $448 in 1957, $474 million in 1958, at the same time we have had this rise in cost. The figures supplied by the Office of Secretary of Defense have indicated that just cost of items has gone up 23 percent in that time, and in addition we have the problem of complexity which is probably more serious.

Has that meant that you have been doing less research than you feel should have been done?

Secretary NORTON. Yes. This brings me directly to the final item here on this line of questions, I think, Mr. Chairman, which is your question No. 4.

You gave me permission to go into that, which I would like now to do.

We are faced with a very, very difficult problem arising from the policy of a fixed dollar level for research.

Mr. LANIGAN. Has that policy been established in the Department?

Secretary NORTON. I wouldn't say that it has been established as a policy. It has, I think, over the years, due to the overall shortage of dollars for the defense effort, sort of settled into a policy. It certainly was the tendency of Mr. Wilson to think in terms of a certain percentage. He always hoped to hold the defense effort at a certain level, and he tended to think of research and development as being a certain percentage of that.

He used to have a way of saying, "Half a billion dollars is a lot of money to spend on research, period."

He had a figure in his mind, as far as Navy research was concerned, of about half a billion dollars as being the ceiling, but I wouldn't say that it has been established as a policy, no.

What has happened here was first shown very clearly by Dr. Furnas when he was Assistant Secretary of Defense for Research. He got up a series of charts which showed what has really happened to the research programs of all three services. I think you have probably seen those.

If you adjust the dollar by the actual Consumer Price Index, which is a good way of finding out what the purchasing power of the dollar really is, and if you leave out the new things that have come into the research program, like the Polaris, which is a tremendous thing and costing many millions of research dollars, if you leave those things out and just stick to the regular Navy research program and compare what that research program is in dollars with the actual purchasing dollar, you get a very illuminating picture.

I don't know whether you can see this very well, but the lightly shaded business there, starting in 1940, running through to 1959, the lightly-shaded part is the Navy research and development program fund.

The darker-shaded part underneath here is the same program funds, adjusted by the Consumer Price Index. You can see that there is a very marked difference between the two.

I believe your staff has furnished you with a complete set of these charts and I think they are very valuable.

It might be a little more graphic if I just give you a few figures here. We have worked up a set of figures from 1940 to 1959, showing the Navy's research and development program funds, adjusted by the Consumer Price Index and leaving out the new things like the Polaris and Vanguard that have come in to upset the comparison, and sticking just to the regular Navy research and development program.

The figures are quite illuminating on this. It shows, for example, that right now in the 1958 budget we have a program adjusted by this price index of $201 million.

In 1951, we had a program, similarly adjusted, of $206 million. In other words, our research effort, dollarwise in terms of the true purchasing price of the dollar has not gone up, sputnik or anything else to the contrary.

This set of figures, is one that might be introduced in the record, if I might. I think it is a very interesting little chart and schedule.

Mr. Edwards points out that the 1959 figures are not up to date.

Mr. Edwards. We could adjust it for you and put in the new figure.

Secretary Norton. 1959 shows 210, which is not much of an increase.

Chairman Dawson. Will you provide us with that?

Secretary Norton. We will adjust that final figure and then turn it in.

Mr. Lanigan. Is that to be inserted in the record at this point, Mr. Chairman?

Chairman Dawson. Yes, it will be.

NAVY DEPARTMENT

Navy research and development program funds, fiscal years 1940–59

[Base 1939–41=100]

[In thousands]

Fiscal year	Navy research and development program funds		Navy research and development program funds adjusted by the Consumer Price Index	
	Gross	Less Polaris and Vanguard*	Gross	Less Polaris and Vanguard*
1940		8,920		9,036
1941		26,315		25,394
1942		47,827		41,657
1943		74,148		60,801
1944		167,658		135,300
1945		231,336		182,524
1946		219,779		159,999
1947		217,951		138,617
1948		206,059		121,781
1949		238,498		142,145
1950		200,303		118,379
1951		376,642		206,023
1952		454,760		243,297
1953		436,421		230,430
1954		365,389		194,021
1955		350,457		185,392
1956	461,606	431,606	239,574	224,004
1957	489,931	378,531	248,885	192,294
1958	520,954	403,747	258,914	200,662
1959	771,489	489,489	374,943	237,892

*Basic Navy program excluding Polaris and Vanguard.

Secretary NORTON. Now, Mr. Chairman, unless there are some additional questions with respect to items Nos. 1 and 4, I would like to go to No. 2 and make a very general statement and ask Mr. Edwards to respond to any details that you might want to get into.

Question No. 2 is problems in budgeting and accounting which adversely affect research and development operations.

Now, the general statement I want to make is simply this. There are three primary areas in which we are adversely affected by budget accounting. First of all, this apportionment process, the apportionment of the funds appropriated by Congress; it results in a "vacuum" the first several months after the start of the new fiscal year, the sort of thing I was describing a little earlier and that Mr. Brown brought out here in his questions.

Secondly, the so-called financial plan, that is a way of spending money which is devised each year by the Department of Defense in conjunction with your budget and, of course, is directly related to the facts of life in the Treasury, how much money is in the Treasury.

Under this financial plan, the carryover remaining at the end of 1 year is a mandatory carryover into the subsequent year, the result being a gradual increase in the carryover total, or an actual inability to use a portion of the funds that had been appropriated.

I would like Mr. Edwards to give you some examples of that.

The third general area is this: The system of expenditure limitations, which result from the financial plan; I have already discussed those in some detail and, again, Mr. Edwards can give you the impact of those on the Navy's research effort.

With that general statement, Mr. Chairman, I would like to ask Mr. Edwards to respond in a little more detail.

Mr. EDWARDS. Mr. Chairman, I would like to start out and make one thing very, very clear and that is that as Controller of the Office of Naval Research, I have a desire to get things going. I am considerably down the line, I am at the operating level. It is my mission, my ambition, I should say, to start out at midnight on July 1 and arrive at the following June 30 and have paid everybody their salary and have seen that the scientists and other people who work for us have gotten their work done as best possible without any interference or as little as possible from ourselves as so-called fiscal people.

The problems that I am talking about are the problems that come to an operating group from these apportionment, financial plan, expenditure limitations sort of thing.

Again, as Mr. Norton said, I don't intend to criticize anybody in the many levels above me. I am sure that they have their reasons for the things they have to do and they have their own peculiar atmosphere that they have to live in as I do. So if you don't mind, I will just confine myself to the effects on the operating end of the business.

Mr. Norton mentioned the apportionment process as being one of the difficulties that we have to live with. As you were well aware, we start making up a budget anywhere from a year to 18 months prior to the time Congress appropriates the money. However, after the money is made available in one form or another, say, on July 1, we start the process again. Prior to our actually getting authority to use the money that has been appropriated or made available by joint resolution, we have to go and rejustify or reexplain everything that is in this budget and get permission to actually use it.

Mr. LANIGAN. Have you done that once or twice before?

Mr. EDWARDS. The review process is a continuous thing from the time the money is budgeted until it is apportioned. There is no doubt that there are changes in the circumstances on which the budget was based. In such a program as research and development, which is so fast moving and dynamic, changes occur frequently. But at the same time, during that 18-month period there are many, many changes in the budget itself. It is not a question of preparing a budget 18 months ago and then having a static thing until the day of the apportionment. It changes constantly.

However, for the last 2 or 3 years, we can't seem to get an apportionment figure—that is, permission to go ahead—for 1 or 2 months after the fiscal year has started. From an operating standpoint this doesn't seem reasonable.

In other words, if we have planned out the whole program and explained it and laid it out in considerable detail, it would appear that come July 1 we should either know that part of it which is not acceptable and shouldn't go forward or we should have been told that it could go forward.

There would seem to be enough time from the operating level viewpoint, to have done these things. However, as of today, the first 14 days of fiscal 1959 have gone by and we have no apportionment. We have a 1-month interim authority.

I might add, as Mr. Brown mentioned, the Congress has not in any way delayed us, because in every year that I can remember, where an appropriation had not been passed, there has been a joint resolution that gives us all the authority we need to go ahead, but we still have to have an apportionment from the Bureau of the Budget and the Department of Defense before we can do anything.

As of this moment, we have an interim authority to operate at one-twelfth of the total appropriation per month. I would like to illustrate, if I may, why this one-twelfth per month, which on the face of it is quite reasonable, is very unreasonable.

The one-twelfth per month, which is an interim authority that we have now pending the completion of an apportionment review and an ultimate decision as to what we may do for the year, was made at a very high level, of course. But down at our operating level we have such oddities as an individual continuing contract, for instance, for one of our major projects that expires in the month of August, early in August. In other words, it requires negotiation, reestablishment, or amendment of the contract in July.

The oddity is that the size of this particular contract is greater than our entire one-twelfth interim authority.

I know this as an operator, but the levels that are establishing the one-twelfth do not know it. I don't say that it is their fault that they don't know it. Perhaps I should have made the observation to them somehow or other. However, the one-twelfth doesn't help us a bit.

There are other contracts similar to this. The biggest help to us would be if the apportionment review could somehow occur prior to the beginning of the fiscal year, so that come July 1 we could get on with our business. Most of the operating personnel in the Navy Department, research and development field, have been planning their research and development program in specifics, in detail, starting at

least 3 months before the beginning of the fiscal year, based on the budget, and that is their plan and they are ready to go. Right at the moment they can't go. They can go in fits and starts, but they cannot visualize their entire year's program so they know what they are going to do and not do.

These thoughts vary somewhat as you move from research up through supporting, applied research into development. On your new weapons system, the importance of the delay is different than it is in a continuing research program. Anyway, that is essentially the problem. As far as difficulties from budgeting and accounting are concerned, you have the apportionment process.

Another thing that Mr. Norton mentioned was the financial plan. Financial planning at the Defense Department level undoubtedly is necessary. I would be the last person to say, as you can gather from my title, that one must not have financial planning. We must have it, if I am to make a living. But, again, financial planning at that level is something different than financial operations at my level.

For instance, the Office of Naval Research some years ago justified, proved to the Congress that it needed a no-year appropriation. Research is a long-term, continuing affair and under this annual increment it proved very difficult to finance and contract for research. After the Office of Naval Research obtained this, I believe the Air Force came in and obtained a no-year appropriation, and others obtained the no-year arrangement.

As far as I am concerned, the financial plan has the effect of converting our no-year appropriation into an annual year appropriation for this reason: The financial plan each year states an amount of money that may be obligated. This amount of money, so far, has always been equal to the amount of money that was appropriated by Congress.

Therefore, if for reasons that seem important to us we carry over not the estimated amount of, let's say, $22 million, as an unobligated carryover, but it comes out to be $32 million, then $10 million is lost. If it represented a series of contracts, which it usually does, which were not executed prior to June 30 for one reason or another, then that $10 million worth of contracts has to be fitted in within the new financial plan obligation limitation. This is an operating problem, again. Perhaps we need greater understanding, something like that, but in the financial plan that is one of the difficulties that hit us.

Secretary NORTON. I think, perhaps, Mr. Edwards, it might make it a little clearer if you mention that it has to be fitted into—the $10 million example that you gave—has to be fitted into the next year's financial plan.

In other words, that is why it is lost to all intents and purposes. Because you have to fit that $10 million that you carried over from the previous year into the next year, you have automatically lost some part of the money that Congress appropriated to you, so the effect of this financial plan, as Mr. Edwards said, is actually to reduce the amount of money that we could spend on research, appropriated to us by Congress.

Chairman DAWSON. Is there a cure for it?

Mr. EDWARDS. Is there a cure for it?

Chairman DAWSON. What is your suggested cure for it?

Mr. EDWARDS. Specifically, since it is a no-year appropriation for research and development, I would merely suggest that in the financial plan there be stated the total number of new dollars to be obligated which would agree with whatever the Secretary of Defense's policy was on the amount of money that should be spent on research and development.

If he has some reason for not spending the entire amount that Congress appropriated, then that would be it. But at the same time it would be highly advantageous if we knew that we could use the carryover, the amount of dollars that came forward unobligated, in the next year.

It might seem that I am trying to get an undue amount of money to use. This is not so. In an appropriation the size of the Research and Development or in an appropriation like it there will be a carryover every year. There is no conceivable way of avoiding it. There will always be contracts that they don't want to sign, because they are not advantageous to the Government. We want to wait a couple of weeks and negotiate further and get a better deal or some breakthrough occurs and compliated negotiations on one particular contract that have been going on are no longer valid.

Perhaps you want to shift the program another way. This is all part of the reason for having a no-year appropriation. Therefore, no matter what happens, there will always be, in an appropriation of this type, a carryover, so we are not getting any additional use of money or anything like that. It will be just the same as it always is, but we want the permission to use the advantages provided by this type appropriation.

Mr. POLAND. May I ask in respect to the apportionment, the use of the apportionment program or process, you are working with no-year funds?

Mr. EDWARDS. Yes.

Mr. POLAND. Are those not apportioned beyond the end of the fiscal year? I have before me the statute which says, "They will be so apportioned so as to achieve the most effective and economical use thereof." Do you get by the 30th of June and not know what you can do with them?

Mr. EDWARDS. Do we get by the 30th of June and don't know what to do with the money?

Mr. POLAND. And have no apportionment of them?

Mr. EDWARDS. No, the apportionment is set up in such a way that there is a total number of dollars that we are free to obligate. Subsequent to June 30, this carryover can be used. It is a no-year carryover, the funds have been approved or apportioned and we are free to use the carryover after that period of time.

Mr. POLAND. As apportioned?

Mr. EDWARDS. As apportioned. Any reserves that were held over are still reserves and not available to us.

At the same time, however, the financial plan establishes a total number of dollars that can be obligated during the fiscal year.

Mr. POLAND. The reason I asked the question was to try to differentiate between the apportionment process and the financial plan which might limit, by allocation, the amount you spend, but apart from the apportionment, am I right about that?

Mr. EDWARDS. So far as I know. The financial plan could reduce the amount of money that is available to you, to a figure lower than the amount apportioned. I don't believe this actually happens, but it could.

Secretary NORTON. It could do it through this carryover process that we have been talking about, for one, couldn't it?

Mr. EDWARDS. It would, in effect, make you fit the excess carryover, that you had not estimated for, into a fixed figure for the following year.

Secretary NORTON. You see, we are talking here about a situation—I was going to call it a "device," but I don't think it is a device that anybody deliberately thought up, but it has resulted in making less funds available to us for research than Congress appropriated and it is something that, in my opinion, ought to be cured.

Mr. POLAND. You mentioned the establishment of reserves. That is a third element that would be involved in the retardation of the expenditure of funds for research and development?

Secretary NORTON. That is an element, also; yes, sir.

Chairman DAWSON. Will you continue?

Mr. EDWARDS. I just want to get the third item, the third large item that gives us difficulty in operating our program, and that, of course, is the expenditure limitation, or, to use the phrase that is used at present, "an expenditure target."

There is a difference here. An expenditure limitation carries with it certain penalties imposed by law if you break it. An expenditure target is the sort of thing that is given to a financial manager with the instruction, "Do your best to hit it." If you miss it a little bit, there is no specific penalty imposed on you. The penalty for missing a limitation, as I understand it, is 1 or 2 years in jail and a $10,000 fine.

We comptrollers are very susceptible to this sort of thing. We act entirely different under such a limitation than we do under a target, where one merely uses his abilities as best he can, to meet this target, realizing that in the estimating process for anything of this size you could be a bit over or a bit under.

The important thing in an expenditure limitation, so far as we are concerned, is the matter of timing. Last year—I don't remember the precise date—the expenditure limitation was placed on the appropriation sometime after the fiscal year had begun. It was a limitation at that time in the exact sense of the word.

It was an expenditure limitation carrying with it all the penalties that I have mentioned.

Since approximately half of 1958 expenditures were going to occur anyway as a result of 1957 work, we had to attempt or at least to figure out how to accomplish a fairly substantial reduction in expenditures with what remained of the program. Mr. Norton told you that we had two choices. We could apply the cut in expenditures to laboratories, because you got more for your dollar there.

In other words, you would get, maybe, 85 percent reduction in expenditures for every 100 percent reduction in obligations you made or you could go to contracts, but there you only received, oh, maybe 40 percent in the first year, 40 percent, 40 cents on the dollar in reducing it. I don't know if you all understand.

If you cut out a dollar's worth of obligation this year you only save 40 cents on expenditures this year because contract expenditures are made over a period of 1 or 2 years.

However, the choice of action is not quite that simple. One can't go to a large number of Navy laboratories and just arbitrarily take away a major portion of the money. This would disrupt the entire operation. One can't fire scientists today and then hope to hire them back next year when you get some more money. It just doesn't work that way.

Since they don't work that way, you try to reduce all of your Navy laboratories in ways that will not disrupt them too much. You don't let them buy equipment, for instance, even though they need it. Need has no bearing on it. You cut back on all their services, their travel, anything they do, short of firing people. However, if a man leaves, you don't hire another one to take his place, you just make out the best you can without him.

In this way you sort of let the laboratory slide into the next year, rather than suddenly cutting off their head and letting it collapse right there. Even this is not conducive to good research and development. In fact, it is conducive to losing your better people.

Mr. LANIGAN. How do the expenditure limitations occur? Who is responsible and for what reasons are they made?

Mr. EDWARDS. The only thing I can tell you is that the requirements for such limitations are established at levels with which I am not too familiar. However, they do come down to us from the many supervisory levels above us.

Mr. LANIGAN. Do they consult with you before they make them or do you just get them handed to you?

Mr. EDWARDS. Mr. Lanigan, it is a little difficult to say "yes" or "no" or call it black or white. We make up estimates of expenditures, they go up the line, come back slightly changed, we discuss it. They will say that ours are not quite right. It is a process.

Then you arrive at a figure and then all of a sudden the total figure is too small to fit your figure. Then there is an arbitrary cut, perhaps. So it is sort of a negotiated figure and then again it isn't. It is negotiated to that figure to which you think you can go and then, out of necessity, it becomes somewhat lower.

Secretary NORTON. What we are talking about all the way through this complicated picture is the fundamental fact that we are facing the defense effort.

We are not putting into our defense effort the dollar volume that the present effort really calls for.

I am not saying what the effort really should be. I am just saying that we are not putting into it the dollar volume that the present effort really calls for. It is a little bit like starting up an engine with a big flywheel on it, and then deciding that the engine is going a little too fast and you want to slow it down to a certain speed.

It is a hard thing to do, because the flywheel has got a lot of good, honest kinetic energy in it and it is represented by a lot of people like Mr. Edwards here and everybody in the defense effort who is doing his level best.

It is a fiscal control problem, resulting from a policy at the top that only a certain percentage of our national economy should go

into defense. I am not saying that this is right or wrong, but this is the result. All of these complicated apportionment processes, financial plans, expenditure limitations, are the result of that overall situation.

Mr. LANIGAN. Do you mean that even after appropriations are made, there is this policy on expenditures with relation to the national budget, so that the appropriation may or may not have a great deal of significance?

Secretary NORTON. There is this slowing down of the effort in order to tailor it to the actual dollars available. It seems to me over this period of years that I have been working in this business here, that Congress takes the point of view of "what is it going to take to create the defense forces that we need?" Then they listen to all the testimony and in the end, they appropriate the money for it.

But the executive has another problem on his hands. He has to go out and raise that money and he has got to evaluate the defense effort of the United States as against all the other things that we are trying to do with the money that is available from the taxpayer.

Furthermore, he has to recommend to the Congress whether we should raise the tax rates or not and so on or whether he should have this temporary relief over the year and the debt limit and so forth.

As a result of all of those considerations, the executive is faced with a problem of slowing down this flywheel a little bit, in order to be sure that he doesn't just run out of dollars in the Treasury. He does this and has been doing it by these various devices.

Mr. LANIGAN. You mention this problem of the debt limit and raising it over the year end. Can you give us a little more information on how that affects your ability?

Secretary NORTON. I would much rather you were listening to Mr. McElroy now or the Secretary of the Treasury, because I am not expert in this.

As I understand it, Mr. Lanigan, roughly at the end of the calendar year, every year, you get the highest part of the curve of cash outlay for the Government. I am not sure why this is, but I think it probably is related to the fact that the calendar year is mostly, also, the fiscal year of almost all of the contractors, whereas on the money-raising side of the business, the highest part of the curve occurs every year in, I think, it is April or May.

Mr. EDWARDS. Yes.

Secretary NORTON. Which, of course, is close to the end of the Government's fiscal year. So you have this disparity: You have one big hump of expenditures which occurs, roughly, 6 months ahead of the other big hump, 5 or 6 months. So it used to be considered a good idea to ask the Congress to allow the executive to have a temporary raise in the debt limit, so that they could actually go out and sell more Government bonds and raise that money over the calendar year end and have the money in the Treasury, actually in the Treasury, when this first hump occurs, on the understanding that when the second hump occurs, namely, the taxgathering hump, they will be back again to the previous debt limit.

This was a very convenient device and I am not aware of all the reasons why it was thought advisable to drop it. Anyway it was dropped and this, of course, precipitated this control system that we are talking about here today. It made it mandatory in effect.

They had to do something in order to control this.

Mr. LANIGAN. Mr. Edwards said a little while ago that he received this plan from a stratum above him. Now, what is the line of command there? Is that intra-agency or does it include the actions of the Bureau of the Budget in the apportionment process?

Mr. EDWARDS. Insofar as I am concerned, it comes first or eventually it comes to me from a comptroller of the Navy who, in turn, gets it from the Comptroller of the Department of Defense and I have to presume that he gets it from the Bureau of the Budget.

The Bureau of the Budget has the problem, the entire Department of Defense has the problem in three services, the Comptroller of the Navy has it in Research and Development, Navy——

Mr. POLAND. Would the Navy be concerned in this matter of the financial plan?

Mr. EDWARDS. I am sure they are concerned about it, yes; because the Department of Defense is such a large portion of the financial expense of the Government; they must be deeply concerned. Let's put it this way: How influential they are in the actual establishment of the Department of Defense's actual financial plan, I wouldn't like to say. I don't know.

Secretary NORTON. I think you may say, though, that the financial plan of the Department of Defense is created in conjunction with the Bureau of the Budget, the Bureau of the Budget sitting right next to Mr. McNeil and his people when the financial plan is worked out, because, after all, the financial plan is merely a reflection of the fiscal situation of the United States Treasury, when you come right down to it.

Mr. POLAND. I was trying really to differentiate between the two actions, one intra and one outside the agency, because you used a metaphor to begin with, about a straitjacket, and I didn't know who put the straitjacket on you.

Mr. EDWARDS. In theory, it comes from the Bureau of the Budget and affects the financial plan. The second is the Department of Defense's internal device.

They are closely lined up, of course.

Mr. POLAND. I think that will make the record a little clearer.

Secretary NORTON. I think if you pursue this straitjacket analogy, which I guess I am responsible for, back to its source, what you really have to do is to say that the straitjacket is imposed by the national policy, itself. It is a matter of decision that the President of the United States has to make in the end. He is responsible in the end for it, as to what percentage of the United States economy you are going to put into the defense effort. That is the straitjacket, really.

Chairman DAWSON. Mr. Edwards, may I ask one question for the record? How long have you been with the Government?

Mr. EDWARDS. With the Government? I have been with the Navy for 11 years. I have to add this up. It has been about 16 or 17 years.

Chairman DAWSON. We are very grateful to you, Mr. Norton, and Mr. Edwards, for your contribution.

We have several questions yet unanswered, but we will have to come to a close now.

I am wondering if you could give us a statement on those others in writing.

Secretary NORTON. I would be glad to; yes, sir.

Chairman DAWSON. I thank you so much for the record. We are very, very grateful to you. This is a matter on which we are deeply concerned, because we realize that research and development is essential to our very existence and we want time to find out how we are getting along, what handicaps we have, and what improvements can be made.

Secretary NORTON. Mr. Chairman, just to be sure that I understand your instructions correctly, now, I take it that you have no further questions with respect to items 1, 2, and 4?

Chairman DAWSON. That is right.

Secretary NORTON. And I will proceed to put in writing my answers to the other questions?

Chairman DAWSON. Yes. I appreciate it very, very much. Thank you.

(Subsequently Secretary Norton submitted the following statement:)

THE ASSISTANT SECRETARY OF THE NAVY FOR AIR,
Washington, July 18, 1958.

Hon. WILLIAM L. DAWSON,
Chairman, House Committee on Government Operations,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: Pursuant to your request at the close of the meeting of the Executive and Legislative Reorganization Subcommittee on July 14, I am pleased to transmit herewith a brief statement on each of your questions numbered III, V, VI, VII, VIII, IX, and X, as contained in your letter to me of July 9, 1958.

I greatly appreciate the opportunity to appear before your committee, and trust you will not hesitate to call on me if I can be of further assistance.

Sincerely yours,

GARRISON NORTON.

III. FISCAL, ORGANIZATIONAL, AND OPERATIONAL PROBLEMS ARISING FROM THE CENTRALIZATION OF CONTROL AND DETAILED DIRECTION OF RESEARCH AND DEVELOPMENT, INCLUDING THOSE ARISING IN THE RELATIONSHIPS BETWEEN THE MILITARY SERVICES AND THE OFFICE OF THE SECRETARY OF DEFENSE

On July 14, in response to your questions Nos. I, II, and IV, I testified at some length on the effect of fiscal controls upon the Navy's research effort.

With respect to organizational and operational problems, I would say that these have arisen as a result of the increasing trend toward separation of authority from responsibility on the civilian side of our Defense Establishment. In the latter days of the Joint Research and Development Board (abolished with the appointment of an Assistant Secretary of Defense for Research and Development in 1953) I had come to feel that all three services were hampered in their administration of research by the increasingly detailed supervision exercised by numerous RDB subcommittees over the various fields of research sponsored by the services. This situation was corrected by the newly appointed Assistant Secretary (Mr. Quarles).

As the staffs of the Assistant Secretaries of Defense have grown, there have been frequent instances of supervision in more detail than I considered necessary or desirable. All three services have protested many of these instances, and I do no feel that the situation in this regard has worsened appreciably. I feel certain that the top level people of the Offices of the Assistant Secretaries of Defense desire to confine themselves primarily to policy matters.

V. UTILIZATION OF THE RESULTS OF BASIC RESEARCH IN WEAPONS DEVELOPMENT

Research begun more than 20 years ago by the Naval Research Laboratory which led to the discovery of radar, the development of the atomic bomb based on the laboratory discovery of the fission of uranium, and the solid state basic research which produced the transistor, are classic examples of the utilization

of the results of basic research in weapons development. It is only through discoveries made in basic research that truly new weapons are developed with marked increases in military capability.

Listed below are a few examples selected at random which are illustrative of the value received from research:

Solid state MASER

As a result of a long program of studies in solid state physics, a new type of solid state MASER (microwave amplification by stimulated emission of radiation) has been developed. The device is a very low-noise, high-gain amplifier in the microwave region. Applications of the solid state MASER to radar and other weapon systems are obvious.

Although the principle has been developed relatively recently, this device is already being incorporated in radio astronomical facilities and equipments included in the Navy's 1959 budget as approved by Congress.

Sidewinder

We have long had an urgent need for a simple, reliable, and readily producible air-to-air missile.

Navy-supported basic research on infrared radiation and the response of certain materials to this radiation, had been conducted to increase our knowledge of the physics involved.

Navy knowledge of the requirements and the applicable scientific research suggested the Sidewinder missile, which homes on infrared radiation from enemy planes. This very effective and relatively inexpensive missile is standard armament in the fleet today, has recently been adopted by the Air Force, and is being given to many of our allies.

New metal for missiles

Advanced solid rocket propellents are vital to the success of the Polaris fleet ballistic missile, but the use of these propellents requires new materials capable of withstanding their hot, corrosive combustion gases.

Research has resulted in molybdenum base alloys which have these high-temperature strength and corrosion-resistant qualities, and which are available in commercial quantities.

These molybdenum alloys are being used more and more in many missile and rocket systems, which pose difficult aerodynamic heating problems, and are under consideration for nuclear propelled aerodynamic vehicles.

Air defense

Modern speeds and attack techniques made manual direction of air defense impossible.

Mathematical, electronic, and other fundamental research led to the development by John von Neumann and others of high speed electronic computers first used primarily for scientific computation.

These computers have the speed and capacity to handle air defense information and form the brains for present and projected continental and fleet air defense systems.

Rocket fuels

The future of the liquid rocket engine depends upon high energy fuels with acceptable ignition characteristics and a low freezing point.

Since 1947 the Office of Naval Research has had a basic research program on methyl derivatives of hydrazine.

One of these—unsymmetrical dimethyl hydrazine—has excellent energy and physical characteristics and is currently being used extensively in rocket engines.

In the solid propellent area of rocket fuels, Navy basic research over many years, primarily in the Naval Ordnance Test Center, China Lake, Calif., has resulted in tremendous improvement in the impulse and characteristics of such fuels. This has resulted directly in making feasible the Navy's Polaris weapon system.

Meteor burst ionization propagation

Ten years ago it was suggested that ionization of the upper air by meteors could interfere with the operation of certain electronics equipment. Further research in this area showed that ionized meteor trails could be used as reflectors for extended-range communications. It was also shown that this technique would be most effective when conditions for normal propagation are least favorable.

High energy fuels

The bulk of the load carried by modern military aircraft is fuel. Increase in the energy content of this fuel can permit either increased range or weapon loads.

Research in basic chemistry, particularly in boron chemistry, had made it possible to develop a potential fuel—boron hydrides—with a tremendously increased amount of energy per pound.

Boron hydrides are now being produced on a pilot plant basis.

Antisubmarine warfare

If we cannot counter the threat of enemy snorkel and nuclear submarines, western civilization is in grave peril. The fundamental problem is detection and tracking.

Basic research on the physical and acoustical properties of the oceans, together with other scientific advances, have made it possible to increase greatly the effective ranges of underwater detection gear.

Low temperature lubricant

The Naval Research Laboratory has for many years conducted a research program designed to improve our understanding of the mechanism of lubrication. As a result of the background of knowledge and experience developed, they were able to solve a critical problem which arose during the Korean war. During the winter, jet aircraft fighting at high altitudes encountered temperatures so low that the lubricating greases used in the machineguns became excessively stiff and the guns malfunctioned. The Naval Research Laboratory developed a grease with the proper characteristics and sent personnel to Korea with the new grease. It lubricated the machineguns satisfactorily throughout the temperature range in which they operated.

Plastic bearings

Basic research on the frictional properties of plastics eventually led to the discovery that thin films of plastics applied on metals serve as a permanent lubricant. More than 200 items on submarines are coated with this plastic lubricant, making it possible to reduce the weight of a typical submarine by 4 tons. Other uses in bomb-release mechanisms, instrument parts, and guided missiles are in an embryonic state.

VI. PROBLEMS INVOLVED IN RETAINING COMPETENT PERSONNEL

The problems of retaining in Government the highly qualified scientific and engineering people we need to carry out our research and development functions have had considerable attention and publicity in the recent past. Since the Navy employs approximately 18,000 professional workers in the scientific and engineering fields, making the Navy one of the country's largest employers of these people, we have a very serious interest and important stake in recruiting and retaining the quanity and quality of scientists and engineers we need.

The Navy has given particular attention to the results of a survey conducted in 1957 to determine the job attitudes of federally employed scientists and engineers. At that time, prior to the enactment of civil-service pay raises, pay was cited as the most important factor in retaining competent people. The recent pay raises, coupled with the recent softening of the labor market, have tended to alleviate this problem for the moment, although the pay for high-caliber professional people is still not competitive with that they can command in industry.

Since the Navy's principal source of professional employees is through the process of recruiting inexperienced college graduates, training and upgrading them within the Navy organization as they gain experience, recruiting good people at this level is vital. The authorization in the recent Pay Act to recruit selected college graduates at the GS–7 level has put our recruiting in the crucial starting level on a competitive basis with industry.

In addition to the provision of more adequate compensation, the Navy and the Department of Defense have been active in effecting improvements in the utilization of scientists and engineers, relieving them of the burden of nonprofessional administrative duties; in providing increased opportunities for higher professional training with consequent career development opportunities; in supporting scientific institutes and conferences and encouraging participation in such professional meetings—all factors in retaining the professional people of the caliber we require.

VII. AREAS IN RESEARCH AND DEVELOPMENT WHERE EFFORTS SHOULD BE CONCENTRATED TO MINIMIZE SERIOUS WASTE OF FUNDS THROUGH DUPLICATION, UNWISE DEVELOPMENT, AND OTHER CAUSES

I do not believe that concentration of effort in research and development work will produce great savings. Indeed the exact contrary may be the case. There is no duplication and waste in basic and supporting research. I am convinced of this. Different scientists will seek different ways to achieve an end result, and this competition is highly desirable. Whatever basis there may be for accusing the services of rivalry (in the derogatory sense), I have never seen an example of such rivalry in the field of research. This field is in a sense self-policing, if only because scientists get no credit for paralleling a trail already blazed by others.

Dr. F. E. Terman, provost of Stanford University and presently chairman of the Naval Research Advisory Committee, wrote me of a lengthly discussion within that Committee on the optimum organization of defense research, and research sponsored by a central Department of Defense agency as contrasted with research in the individual armed services. I would like to quote from that letter: "It is our belief that one of the most dangerous things to the security of our country that could occur would be to attempt to concentrate the control of all basic research of the military in a single office, irrespective of where this office was located in the Department of Defense organization or how well run. Research flourishes in diversity, and overcentralization will stultify it."

Similarly, any measures are injurious which tend to interpose administrative layers between researchers and the men who develop their findings or those who ultimately utilize the developed product. Such measures may make for an apparent organizational tidiness, but in the long run they do more harm than good.

The researcher must know and understand the problems that face his customer. Insofar as possible he should learn them at first hand, but he must be free to help with these problems as he thinks best. He is the unique expert in his field and knows his capabilities better than any administrative supervisor. Mr. C. E. K. Mees, of Eastman Kodak, has summed up this situation as follows: "The best person to decide what research work shall be done is the man who is doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who is probably wrong more than half the time. Then comes a committee, which is wrong most of the time. Finally there is a committee of company vice presidents, which is wrong all the time."

The need for independence of action and competition between approaches, which I have discussed here in relation to research, applies with equal force to the earlier stages of development work. We would make a great mistake to kill off all but one project or approach at this stage. The really remarkable strides in the development of solid fuels made during the last few years illustrate this point. All services pushing ahead have produced results which I am sure no single authority could have achieved.

It is in the later stages of development, when a whole weapon system is emerging, that costs begin to soar and here we stand to gain by a careful selection of the system or systems that will best serve the country's needs. It is only in this phase that the work on different approaches tends to become parallel, rather than exploratory. It is only here that we should concentrate our efforts along the most promising lines.

Let me repeat, the very nature of research work and the close personal and professional links that bind the men who conduct it prevent waste and duplication. In this field there is little or no fruitless effort, for it is usually about as important to know why a theory doesn't work as to determine that it does. My experience has been that the less this activity is channelized from the outside the more productive it is.

VIII. NATURE AND RESULTS OF RESEARCH AND DEVELOPMENT WORK PERFORMED OVERSEAS

There is something about European education and environment that breeds good research. Our country has certainly benefited tremendously from this fact in the past. There is no need to expound on the contributions made to our atomic sciences, for example, by Einstein, Fermi, Bethe, von Neumann, Teller, and many other Europeans whose names come readily to mind.

The Navy has long recognized and profited by the enormous reservoir of research talent existing in Europe.

This has been accomplished through three distinct channels:

(*a*) *Office of Naval Research, London.*—This branch office, established in 1947, is responsible for establishing and maintaining liaison with all scientific research agencies in the United Kingdom and Europe in order to keep us abreast of the scientific endeavor in areas of interest to us. The distribution list for reports from this group includes all major scientific activities, such as the other services, universities, National Science Foundation, etc. They have established themselves as fellow scientists in Europe and as a result have been extremely effective in the gaining of scientific information and winning the confidence of European scientists for over 10 years. They do not contract directly for any research work.

(*b*) *Mutual weapons development program.*—The Navy participates with the other services in sponsoring the development of new weapons for NATO use. We are presently sponsoring 34 projects in 6 countries. The information gained in these programs and the end products of hardware are available for our use.

(*c*) *Navy European research contracts program.*—Under this program, established in 1956, the Navy is contracting directly with the United Kingdom and the countries of Western Europe for specific research programs. At the present time we have 16 distinct research contracts in 6 European countries.

In the days of much loose talk about interservice rivalries, it is interesting to note the outstanding cooperation and coordination among the European research offices of all three services. Regular coordination meetings are held to consider mutual problems and such items as standardized contracting procedures. Detailed project information is interchanged, and at all times each service is aware, not only of those contracts another may have let, but those under consideration.

IX. EFFECT OF MILITARY REQUIREMENTS ON SCOPE OF RESEARCH AND DEVELOPMENT

Military requirements naturally affect the scope of research and development. First, the urgent necessity of maintaining ready forces affects directly the percentage of total funds available which can be assigned to research and development. Second, within the funds available for research and development, there always is a natural desire to fund glamorous but often costly development projects as opposed to the essential supporting and basic research which provide the very foundations upon which our major advancements are dependent. These factors are well known, and it is a management problem to insure the proper balance between the conflicting interests. Within the Navy research and development funds, a ratio between weapons development funds and supporting and basic research has been maintained at about 50 percent for each.

One must realize that the attitude of the armed services toward the importance of research has undergone a radical change since World War II. I want to emphasize this point since I don't believe that it is realized by many who are not familiar with the way we do business.

At the close of World War II, the Office of Scientific Research and Development disbanded and there was no attempt to replace it with a permanent organization. The Navy realized that it must maintain a nucleus of scientific and technical personnel to continue research in areas of particular significance to the Navy and so established the first formal military research organization. This became the Office of Naval Research which for a period of time was the sole source of Government support for this type of work. The other services later established similar activities.

There has been a basic change in our attitude and philosophy toward research. This is shown dramatically if one examines the very significant reduction in time between the attainment of a basic scientific breakthrough and its utilization in the form of operational weapons that have been achieved recently by the armed services.

X. LESSONS TO BE LEARNED FROM CONDUCT OF INDUSTRIAL AND OTHER RESEARCH

Before speaking directly to the question, it should be noted that the Navy has a mechanism well suited to facilitate our learning from the experience of others in the conduct of research. That is the Naval Research Advisory Committee. This group of eminent scientists, many of whom manage the research and development program of our major corporations, universities, and nonprofit

institutions, advises on a continuing basis on all aspects of our research and development programs, including the way it is organized and planned. Thus, we have a ready source from which to learn.

It is necessary to distinguish between research and development. "R. and D." has become a phrase in common usage today. However, it is a somewhat misleading one. The conduct of research is quite different from the conduct of development in both Navy and industry experience.

The first lesson is that most large industrial organizations engaged in highly technical fields find it necessary to conduct basic research. Although no one company itself conducts any large part of the basic research which is relevant to its activities, its own program, in addition to research knowledge, provides it with a group of scientists who are a part of the company and who keep familiar with the work of others in their field of science. This puts them in the position of being able to see advances in science in terms of what it can mean to the company. Commonly the basic research effort is separated from the operating divisions. There are several reasons for this. It reduces pressures to concentrate on applied research, development, and testing; it makes it easier to avoid large fluctuations in level of effort; and the program is designed to have companywide application.

Product development is usually more closely associated with the decentralized operating or producing divisions. The frequent industrial practice is to have a number of relatively autonomous divisions or departments with the organization based on product lines. The operating division is then responsible for its own development program and for that applied research which is an intimate part of its product development. This arrangement facilitates the orderly process from development into production.

Specifically applied to the Navy, the experiences and practices of industry suggest that we need a research program; that it must be within the Navy if we are to get full benefit; that it should be protected from outside pressures to overemphasize applied side of research and from fluctuations of program level; and that development should be conducted by those responsible for production.

The experience of large organizations of all kinds emphasizes the absolute requirement for decentralization. Decentralization of responsibility and authority greatly improves overall efficiency and permits timely action to meet changing situations. Indeed, it has been only through decentralization that effectiveness has been maintained in the face of the inherent inertia of the massive organization.

It is no accident that the organizational pattern of the Navy corresponds rather closely to that often found in large industry. The Navy and industry have been learning about organization from each other for many years.

(Whereupon, at 12:02 p. m., the subcommittee adjourned, to reconvene at 10 a. m., Tuesday, July 15, 1958.)

RESEARCH AND DEVELOPMENT

(Part 2—Military Research Representatives)

TUESDAY, JULY 15, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION, OF THE
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to adjournment, at 10:15 a. m., in room 1501, New House Office Building, Hon. William L. Dawson (chairman of the subcommittee) presiding.

Present: Representatives Dawson, Hoffman, Harden, and Michel.

Also present: Hon. Paul F. Schenck, a Representative in Congress from the State of Ohio.

Staff members present: Orville S. Poland, general counsel; James A. Lanigan, associate general counsel; Milton G. Johnson, professional staff member; Elmer Henderson, subcommittee counsel; William A. Young, staff consultant; and Lawrence Redmond, subcommittee clerk.

Chairman DAWSON. Will the hearing be in order.

These hearings started on yesterday. Mr. Garrison Norton, Assistant Secretary of the Navy, and Mr. Edwards were witnesses.

Today we are going to hear from Mr. Richard E. Horner. He is Assistant Secretary of the Air Force.

We have with us this morning Congressman Schenck, of Ohio.

Congressman, if you wish to ask any questions, you may join in with the committee. We are glad to have you with us.

Mr. SCHENCK. Thank you, Mr. Chairman.

STATEMENT OF HON. RICHARD E. HORNER, ASSISTANT SECRETARY OF THE AIR FORCE, RESEARCH AND DEVELOPMENT

Mr. HORNER. Thank you, Mr. Chairman and members of the committee. I am delighted to have your invitation to appear before the committee to discuss aspects of the management of our research and development program as you have suggested in your outline.

I would note that the suggestion you have made for subjects for discussion properly emphasize the problems of our research and development management. My discussion following this outline, which will be extemporaneous, in accordance with your suggestion, inasmuch as it is a discussion of our problems, it is a rather negative approach to our management.

I would like to point out we are making real accomplishments in our research and development program and it probably is not as pessimistic as our discussions this morning might lead you to believe.

Going directly then to the first item of your suggested subjects, I note that you have listed four factors which influenced the management of the research and development program, two of which are the year-to-year changes in moneys appropriated and the expenditure limitations constitute limitations on the resources that are made available which we can expect to use in furthering the program.

They also constitute usually methods of control of the size and the scope of the program. They are probably necessary methods of control, but if not very carefully used, can lead to gross inefficiencies in the management of the program.

For example, in the case of the first, the year-to-year changes in moneys appropriated, the history of the past 12 years will show that there has been a cyclic variation in the moneys appropriated for support of research and development, largely, I believe, because of different forces that have been brought to bear—the support of the American people is what it amounts to—as a result of national and international conditions.

For just a brief review, we started at the end of World War II with a very modest research and development program in the Air Force and in the process of demobilization this program was practically eliminated.

Over the course of the next few years it gradually built up. We, as a nation, underwent a disenchantment with our former allies, the U. S. S. R. and this had a very decided influence on the increase in support of the research and development program.

We did in the late 1940's, however, experience something of an economic problem in this country and there was decided pressure brought for national economy. In 1948 and 1949 the program was drastically reduced. This was somewhat influenced in 1950 by the first nuclear explosion in Russia, but a more marked effect, of course, was created by the Korean incident.

During the early 1950's then our program support was largely influenced by the activity in Korea and it was during this period when the really major investment was made in the Air Force research and development program.

It was during this period that our command structure was formed, the Air Research and Development Command, the physical structure of facilities at the various centers throughout the United States. There was built up a base of scientific exploration and development from which we have fostered most of our current instruments of war.

As the Korean incident came to a conclusion, there were, of course, again pressures to reduce military spending. This was reflected in the reduced support of the research and development program. It required some program terminations in a not very economical fashion. By that I mean we did not always gain the most for the dollars invested through these terminations. There were small reservations in the support in the next few years, but with the advent of turbojet bombers in Russia, various political activities of our competition produced again fluctuations.

Again, for example, I believe in 1957, the Congress actually appropriated $100 million more to the Air Force research and development program than was requested. This was used late in the year as the result of acceleration of certain programs, again as the result of Russian activity in military research and development.

More recently in our memory, of course, in late fiscal year 1957 and early fiscal year 1958, the pressures brought to bear on Congress and throughout the Government for economy caused us to greatly reduce our expenditure level, again producing some program adjustments and then on October 4 of this past year the demonstration by the Russians in space science caused a rejuvenation of the support of the research and development program and we at the present time are again on the upswing in program activity.

As I mentioned earlier, this does not always produce the most efficient management to a program. I mentioned just briefly the second item which I would like to treat, which actually is the fourth item in your first subject. That is, the expenditure limitations.

We have, throughout the history of our research and development program, up until this past fiscal year, managed our program through the limitations of new obligations of authority that are made available to us by the Congress. This always seemed to be a logical way in which to manage the program because of the long lead time required for military research and development.

We frequently contract for items for development obligating funds that are not actually spent for 2, 3, or even 4 or 5 years after the obligation.

Because of the uncertainties of research and development, our inabilities to predict progress in a given project, it is equally difficult to predict expenditure rates. So, although we had always estimated expenditure rates as part of the accounting procedure, we had never used them as controls in program activity.

The Government, however, last year found itself in a situation where there was a requirement for limiting expenditures, a requirement imposed by the limitations of the national debt, the borrowing capability of the Nation, and under these circumstances we found it necessary to impose expenditure limitations very rapidly.

This, in the Air Force, had the effect of reducing our research and development activity at a rate which was about 7 percent or 8 percent lower than the prevailing rate.

Here again we found it necessary to take certain program actions that were not efficient in producing the largest return for a dollar.

Now, the other two items which are mentioned in your outline, the influence of rising costs and increased complexity of weapons I would like to point out are quite similar if you impose one additional condition to the subject suggested in item 4 in your outline.

The additional condition I speak of, of course, is the condition of the constant fiscal support, or a fixed dollar level for research and development as it is stated in your report.

Therefore, in discussing these two items I would like to consider also discussing item 4, if it is acceptable to you.

The obvious effect, of course, of the inflationary factors is the influence they bring to bear on resource requirements. I would first like to emphasize that they are a real fact of life, that we have consistently experienced rising costs simply due to the factors of increased wages and increased material costs and increased energy costs. These are all the raw products that go into our developments.

We also, of course, experience rising costs because of the increased complexity. The net result is very simple. We can buy fewer re-

search and development projects; we can buy fewer weapons systems. This leads us to a desirable effect, I feel, in a constant pressure for economy of operation. It, of course, leads to problems of judgment as to how economically one can run a research and development project and still get the maximum yield per dollar of investment.

It also leads us to a decrease in the number of weapons systems we can buy and it leads to a decrease in the diversification of these weapons systems.

I would like to discuss a little later in connection with one of the other items the effect this diversification has on our research and development program.

It also, of course, leads to a second ordinary effect in that inflationary trends and the increased costs due to complexity are also very difficult to prognosticate. It is for this reason that we have an additional management problem in estimating expenditures, in estimating requirements for new obligation authority and we sometimes find ourselves underestimating these increases in cost and thus again we are forced to undergo systems cancellation.

Mr. BROWN. May I ask a question while you are on this? I am sorry I got in a little late and did not get to hear all of your statement, but I am very much interested in what you are saying about the costs and the effect of fixed dollar level for research and development.

The Air Force has moved its research and development activities around here all over the country backward and forward numerous times. For instance, you moved one of the research activities from Wright-Patterson Air Base or that area in Ohio, down to Baltimore. Then they determined at a high level they would move it over to Andrews Field, and, in order to do that, they had to move out of Andrews Field and go some place else and that forced some other moves and I do not recall the cost at that time, but it ran into the millions of dollars when they left behind a perfectly good research facility that they had.

Now, does that come out of your fixed fund for research and development or are you spending the money on research and development? Are you spending the money on moving around?

Mr. HORNER. May I review the history on that just a little bit?

Mr. BROWN. Yes.

There are certain research activities of Wright-Patterson now that have moved down to Orlando, Fla., although Wright-Patterson has been one of the great research and development areas. There may be some reason for it, but I am just wondering if those costs are included in your overall appropriation and have some effect on the fact that you do not have all the money you want to spend on research and development.

You are spending too much of it on moving and transferring people and transferring equipment.

Now, go right ahead. I would love to hear the real explanation of it. I have never been able to get one.

Mr. HORNER. Up until 1950 the Air Force did not have a separate organization charged with the responsibility of research and development. We had one materiel organization. It was in 1949—in early 1950, the Air Materiel Command. It was charged with all aspects of our materiel program, which included research and development,

procurement, management of the production program, transportation, supply, and maintenance.

This quite obviously, as the Air Force grew, increased its strength, became too large a responsibility for one organization to handle. It could not be handled efficiently and there was a great deal of feeling in the scientific community, the technical community of the United States that in this circumstance, the technical aspects, the technical progress of the Air Force suffered because of its subjugation to the procurement aspects.

Mr. BROWN. May I interrupt there to say, as I understand it, and as I recall—and I may be wrong about it. You probably know more about it than I do—but that you moved the same personnel, the same people who had charge and who were operating these research activities, they were moved too?

Mr. HORNER. Yes, sir. I was just coming to that.

The Air Force, at the request of the Chief of Staff, had several studies conducted by different agencies and they all came up with the same answer and that was a recommendation to separate the technical aspects from the Air Materiel Command, the technical operation which amounted to the Engineering Division, the Flight Test Division, and certain other small parts of the Air Materiel Command and make a separate command organization from it, and a part of these recommendations was that this new command, out of consideration of the scientific centers of the United States and out of the management relationships of this new command to the headquarters of the Air Force, this new command should be located, I believe it was within 50 miles of Washington, within a very short distance of Washington.

These organizational steps were taken. The Deputy Chief of Staff for Development was established in headquarters, USAF, in the Pentagon and a separate part of the air research and development was established as a major command of the Air Force.

Out of consideration for the recommendation concerning location, a site survey was conducted in the Washington area for a location for this new command structure. As you will probably recall, the first location of the new command headquarters was at Wright Field.

One of the sites selected was in the Baltimore area. The possibility of providing a facility for the new command at that time was defeated by certain problems of acquiring real estate, utilities, and all the necessary appurtenances for such a facility and, as a result, temporary location was established in the Sun Building in Baltimore. This was recognized from the beginning as a rather unsatisfactory location for a major command headquarters.

Mr. BROWN. Were the facilities of Baltimore anything like as good as they were in Ohio?

Mr. HORNER. There was not an adequate facility in Dayton.

Mr. BROWN. They were not adequate, were they?

Now, why would you move, go to the expense of moving those facilities from Ohio to an inadequate space in an office building in Baltimore, when it was inadequate when, as I recall, the Armed Services Committee of the House recommended against it, and then after you get over there and get settled and move everybody, then you decide to move to Andrews Field?

Then after you move to Andrews Field, you have to move people out of Andrews Field over to Illinois some place and part of them down to Texas and around. When you follow that whole thing through, which was done against the advice of Congress and the wishes of Congress, and the cost was tremendous, now the question I am asking you, and I would like to have a direct answer, is, did those costs come out of the funds that we voted for research and development to give us better defense?

Mr. HORNER. No, sir; at that time they did not.

Mr. BROWN. Where did the money come from?

Mr. HORNER. They came out of the maintenance and operation fund of the Air Force, which is the 400 money of the Air Force.

Mr. BROWN. Now, how much more of that is going on? We have had some complaints about transfers down to Orlando. I never thought Orlando was a great scientific center and I am not so sure that Washington is a great scientific center as far as that is concerned any more than Wright-Patterson and the Dayton area, which was the birthplace of all aviation and where aviation actually developed.

I am just wondering what we are doing here, whether we just do not run in one direction and the other, and we spend our time moving operations around with the result that we disrupt the activities and the work of the research people and we move their families here and there and we go to that expense and so forth and so on. Now, what is the real answer to it?

Mr. HORNER. To make the record clear, I should say there was no facility at Wright-Patterson for the headquarters activity. The activity we moved to Baltimore was the headquarters of the command. This facility would have had to have been built at Wright Field.

Mr. BROWN. Well, you had research going on at Wright Field all the time and at Gentille.

Mr. HORNER. And we still do, sir. It has not decreased. In fact, it has increased.

Mr. BROWN. That is not the information I get.

Mr. HORNER. Sir?

Mr. BROWN. That is not the information I get, that it has increased, but that these activities have been moved out of there and, of course, that was the very cradle of the Air Force research program, right at Wright-Patterson. That is where it began. That is where it started.

Mr. HORNER. I am sure if you would like I can furnish you the numbers of personnel and the dollars spent at our Wright Field research and development activity. They have increased markedly in the past 7 or 8 years, by a large margin.

Mr. SCHENCK. If the gentleman will yield——

Mr. BROWN. He is not a member of the committee, but he comes from Dayton and if you want to recognize him that is fine.

Mr. SCHENCK. The chairman extended me the right to be here and I appreciate that courtesy.

At the time Air Research and Development Command headquarters was located in Baltimore, in very inadequate, unsafe situations and facilities, General Power, the commander of the Air Research and Development Command, appeared both before a subcommittee of your committee, Mr. Chairman, and before the Committee on Armed Services. It was the unanimous recommendation of General Power

and the 10 commanders of the air research and development posts throughout the country that in the interests of saving money and in the interests of saving time in the production of weapons systems, that the Air Research and Development Command headquarters should be returned to Wright-Patterson Air Force Base.

It was understood that a building would have to be built wherever the facility was moved, whether it was moved to Andrews Air Force Base, or anywhere else.

It was the unanimous decision, as I have said, and recommendation of the commander of the Air Research and Development Command headquarters, of the Assistant Secretary of the Air Force for Research, of the Secretary of the Air Force, of the Armed Services Committee, and was approved in the House without objection, that that is where the headquarters should be moved.

Mr. BROWN. And that approval was upon the recommendation of the Armed Services Committee.

Mr. SCHENCK. The unanimous recommendation of the Armed Services Committee.

The other steps related by my neighboring colleague, Mr. Brown, have occurred since that time.

Now I understand there is a new report to the Scientific Advisory Board recommending still further staff change to accomplish that which could have been accomplished at a considerable saving of money.

Not only was this the unanimous recommendation of the Commander of Air Research and Development Command headquarters, and his staff, and the Armed Services Committee, but it was still further recommended by an independent industrial research organization of New York, which organization conducted an extensive survey as to the functions of Air Research and Development Command headquarters and followed through on a detailed step-by-step basis, the development of a weapons system and its ultimate use through purchase by Air Materiel Command.

Chairman DAWSON. What is the situation today?

Mr. SCHENCK. The situation now, Mr. Chairman, is that the Air Research and Development Command headquarters is at Andrews Air Force Base. It still requires extensive communications and travel between Andrews and Wright-Patterson. Wright-Patterson Field also includes the Wright Air Research and Development Command, which is the largest post of the Air Research and Development Command.

I would assume it has about 25 percent of the total personnel of the entire command.

Mr. BROWN. And if my information is correct, Mr. Chairman, and as the gentleman has mentioned about how research has increased at Wright-Patterson Field, they are now having to do work that they were doing beforehand, before all these changes were made, except you have imposed another group sitting over here at Andrews Field in between them and perhaps the top level, with the result that we are spending more money on it than we ever spent before and I am just wondering why that situation goes on and why those things were done in contradiction of all these recommendations that Mr. Schenk mentioned by the men in the Air Force themselves, the men dealing

directly with this problem and the recommendations of the proper congressional committees that had jurisdiction, and the action of the House and all of that.

It seems to me it has been a very wasteful and I think, in my opinion—I want to state it frankly—it was a reprehensible thing to do because it could not be justified in any way except somebody up at the top wanted to do it and what many of us are interested in, not primarily in Ohio or in our own districts, what many of us are interested in is getting a good national defense as quickly as we can, an adequate national defense, and to get it as cheaply as we can.

Whenever we go into these diversionary tactics and we waste money, time, and manpower, we are not aiding the program that we want to accomplish, and I still think that there ought to be some report made, Mr. Chairman, to this committee, as to why these things went on contrary to the wishes of everybody, almost, except just somebody that seems—nobody seems to know who it was—and if you will investigate, Mr. Chairman, the moves that were made as a result of finally getting this over at Andrews Field, you will find out that you had a whole chain of reaction through Air Force installations all over the country.

Chairman DAWSON. Are you suggesting that our committee look into that operation to follow the funds?

Mr. BROWN. I would like very much to have a full report on it.

Chairman DAWSON. We will do that, but, in the meantime, we will get back to the witness.

Mr. BROWN. Well, Mr. Chairman, inasmuch as we are talking about how costs go up and so forth and so on, I thought perhaps this would be a good time to bring up why some of these costs have increased someplace along the line.

Chairman DAWSON. We will attempt to start an investigation into that phase of it.

In the meantime, we are interested in research and development and we are interested in the progress that we are making.

We have in mind that we are going to have a reorganization of the military department and this will be covered, but I think we can bring out evidence that can guide them in the future from some of the experiences that you have had up to date, Mr. Horner, and we are trying to follow that to get this information from you in carrying out this study that we began quite some time ago.

Will you proceed, if you can remember where you left off?

Mr. BROWN. I apologize for interrupting, but I know you are not responsible for the situation, but I think it does have—the situation I have described does have some effect on the costs we have been discussing.

Mr. HORNER. May I just say to the Congressman from Ohio that we will be glad to furnish such a report. All of the facts are available.

We have furnished such a report to the Armed Services Committee. When the move was made to Andrews, it was made with the concurrence of that committee. It was finally made to Andrews in consideration of all of the other factors and, as you point out, there were reasons to have the command headquarters at Wright Field. There were also reasons to have it in the Washington location.

I think the final commanding reason was that we did not have to build a facility at Andrews; we had an adequate headquarters building at Andrews and were able to save very considerable military construction funds by making the move to Andrews.

Mr. BROWN. May I add you spent military construction funds in other places to take care of the people who moved out of Andrews Field and other bases as a result of that chain reaction?

Mr. HORNER. A small fraction of the funds that would have been otherwise required.

Mr. SCHENCK. May I also interpolate that $6 million was added to the appropriation bill to provide a facility at Andrews Air Force Base for ARDC headquarters? It was stated at that time that the facilities available at Andrews were inadequate and would not fill their needs so they put a $6 million appropriation in the appropriation bill for this facility at Andrews Air Force Base.

This decision to move from Baltimore to Andrews was based on the profound judgment of a gentleman contrary to the facts in the case.

Mr. HORNER. Mr. Schenck, may I ask, was that not an authorization rather than appropriation?

Mr. SCHENCK. That was an actual appropriation bill because I personally tried to get it taken out of the appropriation bill.

Mr. HORNER. The facility at Andrews in reference to your last remark was inadequate as long as we had the headquarters of the Military Transport Service there. The Military Transport Service was moved to Scott Field and the headquarters of the Air Research and Development took that over.

Mr. BROWN. They moved down to Texas some of the facilities there.

Mr. HORNER. The training command at Scott Field underwent a consolidation of headquarters as a result of necessary economy measures and adjustments in the training program, requiring one less headquarters, so elements of the Scott Field headquarters moved together with elements of another headquarters at San Antonio.

Mr. BROWN. That is right. Now, let me ask you one other question and I am through. I do not want to belabor this thing. Is it not a fact that they did expend public funds to expand some of the facilities at Andrews Field in order to take care of this research and development move?

Mr. HORNER. I would have to check to be certain. I do not think there were any military construction funds spent.

Mr. BROWN. I do not know what you call them. There are all kinds of labels on these funds but it is money out of the taxpayers' pockets just the same.

Mr. HORNER. I think there were some maintenance funds spent in obtaining the building, renewing the building as one headquarters moved out and another one moved in, and providing for a readjustment of the building.

Mr. BROWN. That is all, Mr. Chairman.

Mr. HORNER. If I may then, Mr. Chairman, I will go on to your suggested item 2. I would like to start out on this item by recognizing that the budgeting and accounting procedure is a very necessary procedure in obtaining and keeping track of our resources.

Nevertheless, I shall try to be responsive to the sense of your suggestion in discussing the problems related to budgeting and accounting which adversely affect the research and development operation.

I cannot help but say that I have a sympathetic understanding for those individuals who are charged with the responsibility of budgeting and accounting. It is a very arduous and very often a thankless task. Nevertheless, I cannot help but wish that the procedure could be greatly simplified in that in many respects it does not seem compatible with the necessities of the research and development program.

For example, the budgeting operation, the preparation of the budget within the Air Force for the research and development operation begins each January for the funds for the resources that are to be made available a year from the following July. In actuality, of course, these funds usually become available, not 18 months after the beginning of the budgeting procedure, but more like 20 or 21 months.

Now, in a research and development operation one might almost say that it could only be a sterile research and development program that could postulate accurately what it is going to be doing 18 months to two and a half years from the time that the budget estimates are made. And still we are required in most cases to set down on paper, by line item, accurate proposed costs for items in the research and development program that we are going to be doing on the order of 2 years from now.

This obviously is a somewhat uncertain way to prepare a budget.

Chairman DAWSON. Have you a suggested better way?

Mr. HORNER. I think I can suggest some improvements; yes, sir, and I would like to come to that.

The next action in the management of the budgeting and accounting is at a later date which is on the order of 9 months to 12 months before the actual availability of the funds. It is necessary to prepare a financial plan. This, in effect, is a plan which we will use in actual expenditures of our funds. It is a patent recognition of the fact that we could not have been too accurate in our budget preparations and is an opportunity to repair the mistakes that we made in our budget estimates and prepare additional estimates of how we will use the money.

The final operation of the financial plan, of course, as it is coordinated is adjusted to be in consonance with the operations of the Government in actually providing the budget.

By this I mean that should the budget preparation in its process be changed significantly, then the financial plan must also be adjusted as it goes through its process of coordination to reflect these changes.

It cannot always reflect the final changes, however, because they are made up to the beginning of the actual research and development operation and through the operation. For example, after the money is appropriated by the Congress, it reverts then to the accounting procedures of the Bureau of the Budget, and the Air Force in its fiscal operations as far as the research and development program is concerned, submits a request for apportionment of the money from the Bureau of the Budget in which the elements of the research and development program are again justified.

All of this rather complex and lengthy procedure, of course, leads to the situation where the actual carrying out of the program indicates needs for changes in plans. This again is carried out by a reprograming process where we request and receive, as appropriate, authority to spend the money for purposes in some cases slightly different than those for which originally budgeted or reflected in the financial plan.

Now, one partial answer to your question, I think, stems from my next observation which has to do with the difficulties of conducting these repeated financial reviews and at the same time actually carrying out the research and development program. Obviously the man best qualified to justify the projects is the project engineer. He is the one familiar with the technical details of the projects and can justify the amount of resources required. Also obviously it is impossible for that man to get any work done in actually carrying out his project if he is going to be spending all his time briefing everybody up the echelons of financial control as to the requirements.

This frequently leads to the situation where we can provide at best a secondary order of competence in presenting these reviews. The individual who is making the decision on the financial end of the program is not personally qualified in technical matters, of course. This makes him quite vulnerable to technical advice from many different sources. Sometimes it seems in managing the program that research and development management is a very popular avocation of everybody. The reason being, of course, that there are very seldom categorical answers in research and development. Most answers are answers of degree. Nobody can prove that they are right or wrong until after a given operation is accomplished and therefore everybody is entitled to have their opinion.

I think we can improve the situation by delegating responsibility, decentralization to the people actually charged with the responsibility for carrying out the project.

It almost automatically infers a system of rewards and penalties, a system of rewards for performance beyond expectation and penalties for failure and it also infers a system of trust. We must learn to place our responsibilities in the most competent people who are available, trust them to get the job done until they have proven otherwise and if and when they prove otherwise, remove them in favor of competent people.

I sometimes think it is a disease of government to operate by distrust. It is tacitly necessary to have controls, to have coordination of all of our effort, but the controls themselves need to be very carefully controlled or they will submerge us in administrative action with very little actual accomplishment.

These items of budget justification, and so forth, are not all of the budgeting and accounting procedures, but they are the budgeting and accounting procedures which pertain up to the time of allocation of the resources to the actual project and the project accomplishment. Those accounting procedures which pertain to after-the-fact control, the auditing and renegotiation, have only second order effects on the accomplishment of the programs, but sometimes these are important second order effects.

Something over 90 percent of our research and development program is conducted by contract, either with industry or nonprofit institutions, and our methods of handling these accounting procedures after the expenditure has been made do have a marked influence on the capability and the willingness of industry and especially the profit-taking industry, to invest their own resources in research and development, and this is a very effective source of support for the research and development program.

Because of the decentralization that is possible, an industry's own investment in research and development, either in providing facilities or in providing technical effort, is always very effective by comparison with the resources that can be applied through Government control.

Item 3 on your suggested list concerns the problems which arise from centralization of control and detailed direction of research and development.

I would like to say first that I perhaps do not understand completely the intent of this particular item. In the event you desire discussion concerning the proposals that are now being considered for reorganization, I can only say that I at the present time am uncertain as to whether these proposals do in fact mean further centralization, and further detailed control. Most of the proposals, as they refer to a Department of Defense reorganization—Department of Defense research and development management, create the possibility for further centralized control and provide the tools for detailed management. Whether or not this in actuality will be carried out, I do not know.

Now, in general I feel that a degree—and I would like to point out that centralization of control is always a matter of degree—I think that centralization of control always exists, of course, in any organization or any corporate body. That is why there is an organization head.

I started to say that a degree of centralization of control is also very necessary.

In our own situation in the Department of Defense, I feel it is certainly necessary to have centralized policy guidance to insure a military posture that is in conformance with national requirements, and we also have to have a centralized control to insure departmental coordination, to eliminate unnecessary duplicatory work and to be sure that there are no technical gaps in our research and development program between the various departments.

On the other hand, I would like to make a couple of points as a precaution against too much centralized control. Especially in the last few years, the operation of research and development, the actual technical guidance of a research and development program has become so complex because of the technical state of the art, that it is virtually impossible to manage it by remote control.

The final effective management has to be done by people who are in daily, sometimes almost hourly contact with the program, are familiar with the technical aspects of the program.

Regardless of centralized control or not, in the final evaluation there has to be such an individual. If the centralized control provides more than the guidance which is necessary and the help which is necessary, then the centralized control becomes a burden on the work accomplishment.

Nobody can make a case for having superior technical qualification at the centralized control. If a man is of such qualification that he can have superior technical judgment, to the man who is actually running the project, then they should reverse positions.

Nobody can have the detail of technical judgment that is necessary to actually conduct one of our complex projects.

I furthermore feel very strongly that the actual project management must be carried out in the development of weapons by the organization that is going to use the weapons. The reasons for this are many; perhaps I can best illustrate this by example. I just could not believe that the development of the B–52 could have been possible by an organization that is not charged—I should say the successful development of the B–52 as a weapons system was not possible by an organization that was not charged with the responsibility of using it. This does not mean that some organization could not build the airframe. This, in fact, was accomplished by a contractor. But to make a weapons system there are many more factors than just a vehicle, whether it be a guided missile or an airplane, or a land vehicle. The development has to be very carefully guided by an operational concept, because this has influences on the actual details of development. It is also guided by the competence and availability of operating personnel, so it has a marked influence on the training program, and the training program in turn has a marked influence on the development.

Then in addition to the actual vehicle itself, there is always—and increasingly so in our more complex equipment—a host of items of ground equipment which must be provided in order to make the airplane a weapons system.

Mr. BROWN. May I interrupt right there to ask you a question? I think I agree with the concept you just announced, that the people who are to use these weapons and planes should be consulted in connection with the research and development of them.

I just want to ask you this question: How much were the various officers who are required to fly and to use the B–36 consulted in connection with the research and development on that particular plane?

Mr. HORNER. I just happen to have some personal knowledge about that development.

Mr. BROWN. I notice you smiled a little bit. I too smile a little bit because I know a great many flight officers and others of that type who knew something about the weakness in design of that plane and I am sure you do.

Mr. HORNER. The B–36 was actually developed, of course, during a time period when we did not have the research and development activity of the Air Force organized in its present manner. As a matter of fact, it was developed while the Air Force was a component part of the United States Army. The materiel efforts largely at the time of the B–36 development were carried out at this time in 2 commands at Wright Field; 1 providing services and 1 providing procurement in technical matters concerning our materiel.

Now, I would say that the B–36 concept was developed by a requirement stated by operational units. It was a concept of course, stated during World War II, during the activities of the Eighth Air Force in England and with a long range view toward the military necessities of the Pacific campaign which, of course, at that time we couldn't possibly have a quick conclusion to.

Therefore, the B–36, with its load-carrying capability and its accent on range as a concept, was clearly stated as a requirement by operational people.

The actual management of the B–36 during most of its development career, the senior project manager was a squadron commander in the

Strategic Air Command, and a very competent officer. He is currently in the Air Materiel Command and is still in the Air Force. Certainly from these two points of view the management was Regular and we would do it that way again.

The B–36, however, was greatly handicapped by the fact that it was developed during a time period when the Air Force—when the Army Air Corps was involved in affording its maximum effort to the combat functions. There were many of the people involved in the B–36 development who were rotated from time to time as a matter of personnel policies to combat duties. I have no doubt that the actual development suffered because of this.

Mr. BROWN. Were the pilots of fighter planes ever consulted in connection with the design and development of the B–36?

Mr. HORNER. As a matter of fact, one of the first assistants to General Garrity, who operated the project, was a fighter pilot with combat experience.

The B–36 design, I would say, I think in answer to your question, of course, was a compromise. The necessities for range and load-carrying capability dominated in the B–36 concept. There were later modifications applied to the B–36 such as the addition of the turbojet engines to provide the additional speed and altitude—primarily additional altitude—so it would become more invulnerable to fighter aircraft. The B–36 went through a long and arduous development period.

Mr. BROWN. And were some changes made to eliminate blind spots where they could not see an attack coming?

Mr. HORNER. There was a complete change made in the forward canopy.

Mr. BROWN. In other words, the original development of that plane was not too successful; was it?

Mr. HORNER. The end result was extremely successful. The B–36's were a very effective weapon.

Mr. BROWN. After changes and developments.

Mr. HORNER. I can only say that one must remember the B–36 design was started before the B–29 had ever flown. Up to that time the B–17, which by today's standards is not as big as our fighter airplanes, was the largest airplane we had flown in any numbers. We had some uncertainties in the design and how we were going to carry it out.

Mr. BROWN. That is all.

Mr. HORNER. In conclusion, I would reiterate these two problems which we must carefully watch with regard to centralized control and detailed centralized management. That is the inability of an individual to operate a modern development from any but the closest proximity to the project, and the necessity for development to be carried out by the people who are going to use the weapons system.

As I mentioned at the beginning, Mr. Chairman, item No. 4 I discussed with item No. 1.

Now, item 5, "The utilization of the results of basic research in weapon development."

I would say that basic research must be recognized as the single, the only, the planned—and I emphasize planned—source of new ideas upon which we can base weapons systems. I do not think I have

to sell to this committee the concept of basic research. There are literally hundreds of examples I can give for the conversion of the products of basic research into weapons systems.

The classic example, of course, is the laboratory work that was done in the late 1930's and the early 1940's on radioactive material which identified and isolated the fission of uranium and which led directly to our present position as regards the use and release of nuclear energy.

There have been many, many examples in the area of materials basic research alone which have led to new and very useful plastics in military materiel. They have led to materials which have been useful in high-temperature application, such as a rocket-engine nozzle and nose-cone protective materials.

One other example which I might mention is the work that has been completed in the past decade and a half in solid-state physics, the understanding of which has led to the development of the transistor, which truly revolutionizes the electronics industry by permitting miniaturization of circuitry in electronic components.

As far as projects are concerned, I would like to start off by saying that one problem we do not have in basic research is a problem of duplication. In the first place, since a sound and virile research effort does not really know what results it is looking for in any detail, it would be pretty hard to duplicate that effort. The level of our basic-research program is largely adjusted by the availability of competent investigators. The carrying out of basic research, of course, requires the highest scientific talent.

Occasionally, some case can be made for duplication in management of basic research. This, I think, is more frequently the case in all elements of our research and development program. That is, that duplication exists in management rather than in actual effort. In these cases, some actions must be taken to be sure that similar areas of study be coordinated as far as their management are concerned, to avoid inconsistencies and problems in the actual management.

Mr. BROWN. May I ask one question in that connection?

Does the Air Force promptly share with the research and development agencies of the Army and of the Navy any basic-research accomplishments or developments of weapons that they may work out, or do they sort of hold back once in a while?

Mr. HORNER. One of the later problems I had on my list of notes here to discuss was the problem of communications. It is always present in the basic-research program. This is simply the problem of assuring ourselves that the results of a research program are made available where they are needed. The communication of development results is a rather extensive matter in that you can overcommunicate them.

Mr. BROWN. You can undercommunicate too, at times.

Mr. HORNER. This is not usually the fault. It is usually the problem to assure that there is adequate communication, and I must say here that this is not a problem that is peculiar to relationships between the Army, Navy, and the Air Force, or other Government agencies, or other industrial agencies; it is a problem between scientists and between scientific groups and, usually, it is just a problem of time.

In the first place, it is always an effort to get an adequate report written of a research effort. Most scientists do not enthusiastically approach the problem of writing reports concerning their accomplishments. The actual accomplishment is much more interesting.

Of course, this effect is somewhat ameliorated by the fact that, in most cases, we actually pay for research by paying for the report, and until the report is written——

Mr. BROWN. Once those reports are received, do you immediately make them available to the other research agencies in the military establishments?

Mr. HORNER. Indeed, we do. They are available through the mechanism of the Armed Services Technical Information Agency. The existence of this Agency is well known to all elements of government. I might say that it is used not only by the Department of Defense, but by other elements of government interested in the program.

The reports are made available in toto; they are made available in briefs, and the Armed Services Technical Information Agency—the administrative responsibility for which is that of the Air Force—goes through a rather elaborate cross-indexing system and distribution of the index cards with briefs so that all elements of the scientific community interested in any particular discipline of science know of the existence of that report. We can do little more. It is partly the process of leading the horse to water.

It is very difficult to make them read it if they do not want to, but we have had a marked improvement in the communications problem with the operation of the Armed Services Technical Information Agency.

Mr. BROWN. Thank you.

Mr. HORNER. As I mentioned earlier, one of the largest sources of our basic research is the American university community. We also do a lot of work with other nonprofit research institutes and organizations, and we do some work with the profit-taking industry, where the capability exists.

The very fact that a large part of a research program is carried out with nonprofit institutions creates some management problems. They do not have the same profit incentives and, therefore, the profit method of control of the work is not available. University professors and researchers, being the particularly important segment of humankind that they are, also have certain, I shall not say peculiarities, but differences in the way they like to run their business. They do not like to be under the pressure of profit motivation. Therefore, there are some management expediencies which are necessary in carrying out the research program.

Just one example is the necessity for forward financing. A large part of our business in the research and development program we run on a year-to-year basis, our normal budget cycle.

In the universities, however, and in the nonprofit institutions, we are hiring virtually their professional staffs. In order for an organization to have and maintain a competent professional staff, they cannot be moving their families around every year at the whimsey of the project requirements of the Air Force, for example. They need some assurance of longer range work so that the university itself can adjust its program.

This has led us to the policy of providing in our research program a limited amount of what we call forward financing. This permits us to make contracts for longer extended periods of time, of 2, 3, or 4 years, usually based on the time that we feel is necessary to accomplish a given area of research study.

Item 6 in some ways is related to my discussion concerning basic research. The problem inherent—the problems involved in retaining competent people in the research and development program.

I will not discuss the problems involved insofar as industry is concerned. The industry as a profit taker hires their staff. The motivation of their staff is at least partly, in a very considerable part. induced by salary.

Within the Government I think there is an inherent problem with the employment of scientific personnel in any extremely large organization and it is peculiarly difficult in the Government because of standardization of personnel policies that is necessary in Government.

In other words, we use the same basic system for hiring scientists that we use in hiring clerks. The same system to hire from the top to the bottom.

In recent years, there have been very decided improvements in this system. An appreciable portion of our top scientific personnel, for example, are now hired through special consideration of public laws which permit separate salary adjustment and a higher ceiling salary.

All in all, the area of compensation, recent provisions of this section of Congress have improved the rates; they have also improved the hiring-in possibilities to the point where there are large areas, especially in the middle group of technical people, the project engineers, where I feel the Government is competitive with industry and we do—I think we will show a good record in retaining our technical people.

There is, however, one problem left which I do not have the answer to and I will just mention it as a problem. At the top grades, and mostly in the management area, the technical management area, the compensation is not commensurate with the responsibilities as compared with industry standards. Therefore, we tend to graduate people as they gain experience into a grade in which they can get better positions in industry and we have a higher turnover because of it.

This also, of course, has some effect on the lower grades in that a lower grade engineer or scientist can see the opportunities for his advancement limited.

There are other problems peculiar to retaining competent people in a military organization. The mix of military and civilian in any facility or in any organization is usually considered by the civilians to be disadvantageous to the civilians. The reasons for this, I think, are quite obvious. The military people in uniform are primarily in uniform for combat duty.

Because all personnel policies are adjusted in that respect, all officers are trained for command duty and with very few exceptions the very top management of all of our technical facilities, the top management positions are held by military people. This filters on down, of course, through the organization since it is usually the inherent desire of a military commander to have his top deputies also military and thus we frequently have situations where laboratory chiefs, division chiefs, section chiefs, and branch chiefs are also military.

Now, this is not an easily solved problem. If one made simple rules to the effect that the most competent individual would hold the management position in one gage of competence, his experience, which is certainly unavoidable, then almost without exception over a period of time all of our technical installations would become civilian managed and in turn this would create a problem in introducing military requirements and military thinking into the program.

We are constantly striving for the amelioration of these effects of a mixed operation.

For the technical officer himself, some of these same effects seem to make his technical career, his seeking of a technical career, disadvantageous to himself. It has been—I think it can safely be said that our personnel policies tend to rotate officers too often. There are exceptions, of course, but they tend to rotate the officers too often for them to retain the necessary degree of technical competence.

Item 7 concerns the areas in research and development where effort should be concentrated to minimize the waste of funds through duplication.

I think it is necessary to preface this discussion with some explanation as to how we arrive, in the research and development program, at a useful weapons system. If we take the research and development operation in chronological order of accomplishment, the first element, of course, is the basic research program which we hope produces useful ideas, which has proven in the past to produce useful ideas. This is, as I said, the first operation and I want to specifically make the point that it is the most economical of our resources.

In this area we are only buying a competent investigator. His operation is largely one of study, so we pay his salary in pencil and paper and small desk tools.

Recognizing a useful idea or an idea we think might be useful, we then carry it into the applied research program for feasibility determination—the determination of feasibility of military usefulness. This, in addition to some assistance to the original investigator, probably also requires some laboratory space and equipment and is a little more expensive, but is still not very expensive in terms of our overall program.

As we go from step to step through this program, of course, certain elements are weeded out as we determine that some ideas are not any good from the basic research program; the feasibility program in turn indicates that certain accomplishments are not feasible and they in turn are weeded out and we carry those that are successful into the technical development program where we engineer the components, the elements which might ultimately be useful in a military system.

Such components as guidance systems, electronic components, structures, propulsion systems, and so on. Here, of course, we get significantly into material costs and large numbers of engineers. This gets to be a rather expensive program.

From the successful component developments, then we integrate the weapons systems. Each weapons system is made up from the building blocks furnished by the technical development program.

As I have mentioned previously, the weapons system programs are in each generation becoming more complex because of performance demands and because of technical capability. As they become more

complex they become more expensive and the weapons system development program is exceedingly expensive.

Now, I point these elements of the research and development program out because, as you see, as we go along, they become more and more expensive, the demands for selectivity become stronger because we cannot possibly support all of the possible things that we could do in research and development, but at the same time, of course, we are producing more information and better information upon which to make our decision for selectivity. Again, contrary to that point as we go along, the pressure for continuation of a project increases. As it becomes closer to military reality, the military itself recognizes a capability which they do not want to give up. The industry, which has now become deeply involved, is enthusiastically supporting each weapons system development in the hope that it will lead to mass production, which is the real source of profit as far as American industry is concerned, and so it becomes, as we go through this process, more necessary to exercise selectivity, more difficult to exercise selectivity from the outside pressures that are brought to bear, but more rational to exercise selectivity from the basis of the information that we have available.

We must be very careful about a couple of points here and I think it is all of our responsibilities to educate the people of this country in the fact that this process of exercising selectivity does not indicate research and development failure. This is a very difficult problem, especially in our management system. When we terminate a project, it is almost invariably hailed in the Nation's press as waste with a dollar amount attached to it. It would be much more salutary to the program to recognize that in actuality it is a form of success if it is properly carried out.

(1) Because there are also research and development accomplishments in the program which can be used in other areas and (2) we exercise this selectivity only because we have reached the point in the simultaneous developments of systems for the same purpose where we can identify the best system and it is no longer profitable to carry on a duplicating program as insurance.

There is just one word of caution I would like to add here and that is that there are always some pressures, also, to exercise economy by canceling developments that do not compare favorably with other developments that are further behind them. Process of cancellation of developments that are just going into production because a system that is on the drawing board looks so much more attractive is exceedingly dangerous and exceedingly wasteful, so we have to keep all of these things in proper perspective in investigating these areas for saving.

The research and development operation which we carry out overseas seems to become a little more comprehensive every year. This results from the increased strength of our NATO alliances and the realization—I think at least the gradual realization of the people of the United States of the fallacy of isolationism. We must cooperate with technical efforts of our allies because it is increasingly important that we maintain technical superiority over our competition in the absence of quantitative superiority.

Chairman DAWSON. What do you mean, "in the absence of quantitative superiority"?

Mr. HORNER. I think it is agreed in all areas that there are several important military areas in which the countries behind the Iron Curtain have quantitative superiority. Specifically, of course, in ground warfare. I do not think we could begin to match their numbers of divisions and the ground vehicles that they can put against us.

There are certain kinds of airplanes in which they have more numbers, and their geographical location is such that it has an influence in some areas as making airplanes more effective. For example, they can certainly hit a large portion of important American targets that are employed in Europe with shorter range weapons than we can frequently use because of the initiative we give them as a matter of national policy.

In actually carrying out this research and development program in Europe, I want to emphasize that we do it on a cooperative basis with our allies and with the technical community and the technical industry of our allies.

We have in the Department of Defense a mutual weapons development program, of which one leg is the responsibility of the Air Force. We currently have a team of research and development managers in a Paris office which negotiates directly with the governments of our allies in establishing technical projects with indigenous industry. At the current time we have 23 different projects with 6 different countries and we are negotiating some projects with 1 or 2 other countries.

The total cost of these contracts at the present time is slightly over $100 million, of which we pay about 53—at the present time we are investing 53 percent. The rest of the investment comes from the governments of our allies. These projects range all the way from aircraft through electronics and all of the other developments in the science of warfare; at the present time we are proposing a small expansion of this effort in the coming year.

We are negotiating on several projects and pending the availability of resources, we will add to the present contract level something on the order of $25 million to $50 million. This is again the total contract level and our share again will be approximately a half of that.

We also, in connection with this program, operate certain facilities in Europe for the benefit of our mutual defense posture. For example, we have an aerodynamic training center just outside of Brussels where we are furnishing a part of the financial resources and the management of the staff. We are also furnishing certain equipment and we are furnishing technical guidance.

Aerodynamic test facilities are in dire shortage in Europe and this is a facility which is paying off large dividends in training European scientists in testing techniques.

We also operate at our expense a small air defense technical center at The Hague in the Netherlands. This is operated by contract with the national research organization of the Netherlands. It is manned by scientific personnel drawn from all NATO countries. We also have technical personnel over there.

The center was established at the request of the Supreme Allied Commander in Europe and is responsive to the needs of SHAPE, at the present time in designing the air defense system for Europe. I am sure you realize the air defense of Europe is extremely important not only to those units which we have deployed in Europe, but it is

also extremely important to the continental defense of the United States since it might very well be the first warning we would get of any attack.

We also conduct a modest, but very effective research program in Europe. We maintain an office of scientists in Brussels which contracts throughout the NATO countries with the very best scientific talent that is available for studies which are useful to our military program in the United States.

Item No. 9 is stated in a way which at first might be a little startling because it might also be stated in reverse, I think. The question of whether military requirements really affect the scope of the research and development program more than the research and development program affects the military requirements.

The basic research and the technical development, which has most to do with advancing the state of the art really has a very dominant effect on the statement of military requirements. In the actual determination of military requirements, you might say that there are three ingredients. One is the threat which is posed by the military competition. The other is the—another is the resources that are available in personnel and money to accomplish the requirements, since it is not very useful to have more than a passing glance at a requirement which you obviously cannot carry out.

The other is the technical status or the state of the art which will permit activity to satisfy the military requirement.

On the other end of the research and development operation spectrum, however, it is accurate to say that the military requirements are all controlling in influencing the development of weapons systems. All of our weapons systems are undertaken in response to a statement of military requirement stemming from the operational needs.

Now, just a general, broad statement of military requirements would be that a military commander always has a requirement to reduce in vulnerability of his offensive weapons to the very minimum so that he can, without question, penetrate any military force that is posed against him and increase the vulnerability of the weapons that are in turn posed against him to the maximum.

This means he wants the very best defensive force and the very best offensive force that he can get.

One very dominant capability in attaining this goal is that of fielding a diversified force of weapons. A weapon, regardless of how good it is, cannot be a single answer to all military requirements. It is too easy to defend against a single weapon force. So every military commander wants as many different kinds of weapons as he can possibly post against the enemy because it in turn diversifies his defensive problem, as many different kinds of weapons as he can economically operate with the resources provided him.

This, in turn, of course, has a very marked influence on our research and development program since it always leads to the initiation of large numbers of different kinds of weapons developments which in turn leads to the problem of selectivity that is posed by economic necessity.

In the last item that you have suggested, I have presumed that you are suggesting a discussion concerning the lessons we can learn from watching the management methods of other organizations in carrying out their research and development efforts.

There are real lessons to be learned in this observation. One, of course, is the lesson of size. We have within the Air Force the largest research and development program to manage that is known in the free world, that we have access to information on for management techniques.

There are many things that can be accomplished in a smaller organization in the way of management techniques which cannot be adopted in toto for our use, but which do provide useful examples to us.

I think one of the major lessons we can learn is one which I have alluded to previously and that is one of trust. I think you can look about the country in our free economy and see the most successful industrial and university research and development programs in those organizations where adequate consideration is given to a proposed research and development program before it is started.

A final decision is taken in the light of all the best facts that are available as to total costs of a program, and the ultimate objectives and the probability of obtaining success.

If a positive decision is made to proceed with the program, then a competent director of the program is chosen, the resources are made available to him, and he is expected to produce. He is not given guidance at many different echelons of organizational structure in the details of carrying out the program. The profit motivation, of course, has some influence on this. If the man obviously fails, he frequently does not hold his job.

There are certain latitudes, of course, available in this kind of an organization for providing these incentives and penalties which make the system work much better than it could work in our current system.

On the other hand, we are faced with the problem in Government research and development of always justifying our actions, usually on a fiscal period basis, without relationship to accomplishment in the development cycle.

These justifications are apparently necessary to a degree in our system of government. I think it is necessary, as I said previously, to reduce these kinds of controls. They have inbred with them management methods which make the actual carrying out of our program very difficult.

As a matter of fireproofing, each echelon of managment requires more detailed reports, more control mechanisms from the echelon below it in order that that given echelon can be responsive to the echelon above it. One obvious effort then should be to reduce the number of echelons.

When it comes to the actual relationship of government to industry, the actual contracting officer and the actual project engineer must protect himself from all of the management requirement above him. His method of doing this is requiring that each operation be carried out in conformance with extremely detailed specifications.

It would be extremely desirable if we could invent a system where we could tell a segment of industry what our objectives were in military performance for a given piece of equipment and agree to pay him a given sum for fulfilling those objectives and not oversupervise him in the method of attaining those objectives.

I am sure that in such a system he could produce much more cheaply, much more rapidly. There are reasons, however, why this is impossi-

ble, one of which is our method of control. Another is our efforts at standardization so that we make each segment of industry conform with the practices of other segments of industry. This, to a degree, is necessary for the operation of a military system which has the responsibility for training people for using these equipments.

I am sure there is no patent solution to this problem. It is a problem which requires very careful consideration at all times, a reluctance to multiply management on top of management because the most deteriorating effect is, as I mentioned previously, the placing of echelon on top of echelon.

That has been a very brief statement of my response to your suggestion. I hope it is satisfactory to your needs.

Chairman DAWSON. Do you have some questions?

Mr. LANIGAN. I just wanted to refer to the report of the ad hoc Committee on Research and Development of the Scientific Advisory Board which came out a few days ago. They point out as follows on page 5 that—

> there has been a growing tendency within the Government and the military to centralize authority, thus removing it from the operating units which still have their responsibility. This philosophy has seriously affected research and development.

I take it from your statement you agree there has been an increasing amount of this centralization which has led to this more undesirable situation that you have just described.

Mr. HORNER. I could not help but agree with the accuracy of that statement. The centralization of control, as I mentioned previously that is bad, is the kind of detailed project management that tends to come from top echelons to lower echelons.

Mr. LANIGAN. You find the project officers not only have to report to the Air Force Central Headquarters, but in turn the Air Force Headquarters has to report to the Office of the Secretary of Defense in greater detail, you believe, and more frequently than you believe desirable.

Mr. HORNER. I should not like to leave the impression that this is a problem outside of the Air Force. It is a problem within the Air Force as well as outside of the Air Force.

I think it is a natural organization problem that every organization suffers from. I do not think we have paid enough attention to it in the Department of Defense to eliminate unnecessary echelons of management and to restrict the activities of the management echelon to that of providing policy guidance.

Mr. LANIGAN. Do you find that the Office of the Secretary of Defense goes into technical detail when they review a project and the progress of the project?

Mr. HORNER. They frequently do go beyond my estimate of necessity. I would emphasize this is my estimate of necessity and I will admit being possibly biased in this.

Mr. LANIGAN. Of course, that gets back to your problem, Is there any reason to feel that they, being removed from the project, are more competent to review the details than the people whom you have hired at considerable expense to actually carry on the project?

From your experience, are they as well trained in the technical field as your operating people?

Mr. HORNER. Let me say I would be hard put to think of an example where a technical contribution has been made from a top-management level, but I can think of many examples where delays have been created by the raising of technical questions.

Mr. LANIGAN. Now, in the Department of Health, Education, and Welfare, we find that decisions are made to carry out certain medical research projects. The matter goes up to the top of the Department one, then the policy people make a judgment on whether or not that project should be carried out on the basis of their management knowledge and fiscal knowledge and if the decision is made to carry out the project, it is then returned to the operating level to carry out and is not then constantly reviewed—that is, once the decision is made to go ahead, then the operating people are allowed to carry it out without having to report back.

Do you think that something like that could be instituted in the Department of Defense?

Mr. HORNER. Here again I think that kind of an operation is extremely desirable. It would probably have to be qualified to some degree because of the question of size in the Department of Defense. We cannot avoid the fact that we are spending vast sums of the taxpayers' money. The taxpayers and their representatives have a justifiable interest in the day-to-day accomplishment of the program. So it is probably not adequate to say, "Well, we can just accept a $500 million proposal here," and then give it to somebody to carry out.

There are undoubtedly necessary some additional controls, if only for information purposes. I think we have far too many at the present time.

Mr. LANIGAN. One thing that has occurred to me is that a task force, or groups of task forces might be set up wherein representatives of these various levels which must consider the problem could, as a group, review these technical matters and reach some decision on them without having to go through the numerous individuals in the various levels. Do you think that a task force approach might be feasible?

Mr. HORNER. We have used this technique for certain very important programs, the most recent example of which is the ballistic missile program.

In 1955 the Air Force recommended a system of management from the project level through the Secretary of Defense, eliminating most of the echelons of management. Within the Air Force the project team was asked to report directly to the headquarters of the Air Force where it underwent one review by a committee that was chairmaned by the Secretary of the Air Force and had component representation from the Air Staff, and the Office of the Secretary.

We also recommended to the Office of the Secretary of Defense that such a committee be organized in the Office of the Secretary of Defense and this was done. This has been a very marked improvement in the management. The management of this program has certainly proceeded at a better rate than any program it has been my experience to be associated with. Of course, there is a limit to how many of these task forces can be formed. It would not be practical to have a task force for every project that we carry out. It certainly would be practical to use this management expediency in very important programs, and, incidentally, very expensive programs.

Mr. LANIGAN. Now, earlier in your testimony you referred to the fact that costs of research are increasing and complexity of research on weapons is increasing and I notice that in the figures that I believe the Office of the Assistant Secretary of Defense for Research and Development supplied to the committee, we have seen that the amount of dollars available has fallen in the past, although it is picking up again now.

That is, they fell from around $525 million in 1953 to about $431 million in 1956 and 1957.

In view of the rising cost, and the amount of dollars that you have had, do you feel you have been able to keep up the type of research and development program we really need to maintain adequate security for this country?

Mr. HORNER. I am not satisfied with the current level of our effort in various elements of our research and development program. I should hasten to add, I guess, that I have never been satisfied and in some respects it is my business to be dissatisfied, since one function of my office is to endeavor to provide the necessary resources to maintain the program. I am influenced greatly by the knowledge of certain very valuable development efforts that would appear to have very useful military uses that cannot be carried out within the context of the present program.

It is not my business, however, to ultimately say what are the quantities, or diversification of weapons that are necessary in the entire Department of Defense in order to provide for our national security.

I do feel that within the Air Force it is extremely difficult to keep a balanced program with the resources that we have. I probably should enlarge on that just a little. The funding of weapons systems developments, in spite of the fact that they are extremely demanding on our total resources, is always easier to justify because they are closer to the promise of real military capability and almost everybody in the management circles can understand exactly what they are going to be used for, and, in the second place, they are always strongly supported by industry and we get a lot of help from the particular element of industry that is responsible for a given weapons system, in justifying its requirement.

On the other end of the spectrum, the research program is substantially funded as needed. This is not to say we could not use additional money in the basic research program, but I am relatively satisfied with the level of effort we propose for this next year.

Now, this leaves the large middle area of technical development, the invention of components to suffer along on those parts of the resources that are left over from these other two efforts, you see.

We do not have adequate support at the present time for the technical development area. I am afraid this will have an effect in the period 2 to 5 years from now, of either making our weapons systems development program grossly more expensive because we will have to undertake on certain developments in the light of the building blocks that are necessary, or we just will not have adequate weapons system development.

Mr. LANIGAN. In the last few years, Congress has either appropriated what money has been requested or even in 1957 I believe appropriated $100 million more than was requested.

Do you feel that Congress, as far as it has been able to, has been supporting the program? Where are the hitches in getting the support that you need?

Mr. HORNER. They are both internal and external to the Air Force. First external to the Air Force up until last year it has always been—up until this past year it has always been the policy for research and development guidelines to be given to the Air Force which indicate the level of research and development appropriations. This, in effect, was also accomplished last year by comparison with last year's operations.

Within the Air Force, of course, there is always the problem of dividing the total resources that are made available to the Air Force, dividing them up and providing the best balance between the force in being and the program in the future

As you know, the actual support of the research and development program is a relatively—the actual fraction of the research and development program that is supported by research and development appropriations is relatively small.

By far the largest part of the research and development program is supported by procurement funds. This, in itself, is a major management problem in the Air Force. The Air Force has a different problem than the other departments have in that the Air Force is the one department that has a single contracting authority.

The only procurement authority in the Air Force is the Air Materiel Command. A part of that authority has been delegated in certain specific areas to the Air Research and Development Command, but this creates a situation where one organizational element in the Air Force controls the resources for the research and development effort. Another organizational element has the operational responsibility. Well, this obviously leads to administrative confusion, sometimes management competitive problems, and we are looking very closely at this problem at this time, seeking a better solution to it.

Now, this occurs in the Air Force, as I said, because we have the Air Force organized on a functional basis and our funding is on ostensibly a functional basis, but in the actual amounts of money appropriated it is on a command alinement basis.

It occurs partly because of past history in the Air Force. As I pointed out earlier to the gentleman from Ohio on the research and development it stems from the present procurement organization.

Chairman DAWSON. Thank you very much, Mr. Horner.

You did not give us your background when you started. Would you do that?

Mr. HORNER. I do not have a written background with me. I can give it to you verbally or furnish it to the committee later, whichever you prefer.

Chairman DAWSON. Whichever way would best suit you.

I want to compliment you on your testimony this morning and I see the justification for not having a written speech in that I think you have talked to us more frankly than you would have in a written speech, and I think you have talked to us more impressively.

I think we understand your problems a little better than if you had given us a prepared speech. It is seldom that we get a witness before us who knows his subject matter as well as you do and that is why

we particularly wanted your background, and so forth, that it might be made a part of the record and in order that we might have it with us.

Will you introduce the gentleman who has sat with you and who has kept silent all the while?

Mr. HORNER. Thank you, Mr. Chairman. He perhaps has kept silent because I talk too much.

Mr. Mebin is with me, who is my assistant for programing activities in research and development.

Chairman DAWSON. We have been happy to have you with us. Come back to us again soon.

Mr. HORNER. Thank you, sir.

(The biographical sketch of Mr. Horner is as follows:)

BIOGRAPHICAL SKETCH OF RICHARD E. HORNER, ASSISTANT SECRETARY OF THE AIR FORCE, RESEARCH AND DEVELOPMENT

Richard E. Horner was born on October 24, 1917, in Wrenshall, Minn. He received a bachelor of science degree in aeronautical engineering from the University of Minnesota in 1940 and a master of science from Princeton University in 1947. Commissioned as pilot, second lieutenant, Army Air Corps, in November 1940, he served as commanding officer of the 86th Bomber Squadron and operations officer of the 47th Bomb Group in North Africa. He was awarded the Silver Star, the Air Medal with four clusters, and the Presidential Unit Citation. Subsequent to his return to the United States he was assigned to the Flight Test Section, Engineering Division, Air Materiel Command, where he held positions as Assistant Technical Executive and Chief, Test Engineering. In December 1949, Mr. Horner was released from active duty in the grade of colonel, USAF, and was employed in a civilian capacity at the Air Force Flight Test Center where he later became Technical Director in January 1952, holding that position until his assignment as Deputy for Requirements to the Assistant Secretary of the Air Force for Research and Development on May 9, 1955. Mr. Horner was appointed Acting Assistant Secretary for Research and Development on February 28, 1956, and became Assistant Secretary July 8, 1957.

Chairman DAWSON. The subcommittee stands adjourned.

(Whereupon, at 12:20 p. m., the subcommittee adjourned, to reconvene at 10 a. m. Wednesday, July 16, 1958.)

RESEARCH AND DEVELOPMENT

(Part 2—Military Research Representatives)

THURSDAY, JULY 17, 1958

HOUSE OF REPRESENTATIVE,
SUBCOMMITTEE ON EXECUTIVE
AND LEGISLATIVE REORGANIZATION,
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m. in room 1537, New House Office Building, Hon. William L. Dawson (chairman of the subcommittee) presiding.

Present: Representatives Dawson and Brown.

Also present: Orville S. Poland, general counsel; James A. Lanigan, associate general counsel; Milton G. Johnson, professional staff member; Elmer W. Henderson, subcommittee counsel; William A. Young, staff consultant; and Lawrence Redmond, subcommittee clerk.

Chairman DAWSON. The subcommittee will come to order.

We have with us this morning Dr. William H. Martin, Director of Research and Development for the Department of the Army.

Dr. Martin, you may begin at any time you wish.

STATEMENT OF WILLIAM H. MARTIN, DIRECTOR, RESEARCH AND DEVELOPMENT, DEPARTMENT OF THE ARMY, WASHINGTON, D. C.

Dr. MARTIN. I would like to say in starting off that I am informed you have already had people here from both the Navy and the Air Force, and I understand you want me to discuss these 10 questions that were submitted with your letter asking me to come this morning. Since you have had these previous discussions, I do not want to belabor these points too much. So I will maybe talk on the shy side and depend upon questions to go into anything that you think I have missed and that the others may not have covered.

The CHAIRMAN. Doctor, will you please give your background and experience for the record?

Dr. MARTIN. Mr. Chairman, I have been in development and research work since 1911, first with the American Telephone & Telegraph Co. until 1934, and then I was transferred to the Bell Telephone Laboratories, which is part of the Bell System where I continued to be engaged in research and development work. I retired in 1954 as vice president of the Bell Telephone Laboratories in charge of development, and went into the Department of Defense as a Deputy Assistant Secretary for Engineering.

In September 1955 I took my present job as Director of Research and Development for the Army, which is a position reporting to the Secretary, and operating at a level of the Assistant Secretary.

Before discussing these particular questions, I would like to make one comment about a matter that has caused a lot of discussion in hearings of this sort, and that is about the matter of making up the budget. Budgetmaking is a process, first, of competition between divisions of an organization for resources to carry out the work that they wish to do; second, of divergencies of opinion between the managers of the divisions of these organizations represented, and also divergencies of opinion between them and the head of the organization who has to get the resources; and last, of the resolution of these competitions and divergencies by top management.

As a result of this, you have a situation which is shot through with struggle and controversy. So there is bound to be a lot of discussion as to the propriety of what finally comes out of such a budget operation, and this is true, I would say, not only in Government, but also in industry.

So, it is a natural thing to have differences of opinion expressed in connection with establishing and carrying out a budget.

My second comment. Before I get on these questions, as I mentioned earlier, there have been witnesses here also from the Navy and the Air Force who have discussed these same matters and questions. My purpose here is not to belabor these points too much, but to depend upon questions which you may wish to ask me to bring out anything you think I have not covered, or which the other people have not covered that you wish me to discuss.

Going to the first topic, "The effect of (*a*) year-to-year changes in moneys appropriated," this is a matter that is very fundamental to carrying on a research and development operation because to carry on such an operation you have to establish groups of people—skilled people—and facilities to support them. You cannot build up and tear down an organization of that kind from year to year. You have to more or less maintain a steady rate of activity in order to do it efficiently and effectively.

Therefore, any large swings in moneys from one year to another are rather hard to absorb without losing efficiency and really without running up expense.

The matter of rising costs, which is one of the topics here, has also confused the picture in recent years, because of the inflation. As I remember the figures, the dollar in 1955 is worth about 80 cents in 1959. So you have that situation.

Mr. BROWN. How much did you say?

Dr. MARTIN. A dollar in 1955 is expected to be worth about 80 cents in 1959.

In order to get the same amount of effective dollars available you have to increase your 1959 total by about 25 percent in order to equal the 1955 total.

Another factor that comes into this matter of funding research and development is the increased complexity of weapons and, weapons being more complex, there are more questions to be answered and more investigations to be carried out, and that, of course, runs up the cost.

Corresponding to that, or collateral with that—with the increased

complexity—you require more complex facilities to check and test these more complex weapons. As we build more facilities and while those come out of capital costs or military construction funds, the maintenance has to come out of the annual budget. Therefore, the more facilities you get to do your research and development job, the more maintenance cost and operations cost you have for this facility, which also have to come out of the research and development appropriation.

I remember in the case of the Army the proposed 1959 research and development budget for the Army, while more than $100 million up as compared to 1955, due to the rising costs and due to the increased facilities required, and not taking into account the effect of the increased complexities—this over $100 million increase in the research and development budget for the Army means we have about the same amount of effective dollars to carry on our research and development activities as we had in 1955.

Chairman DAWSON. Do you feel that is enough?

Dr. MARTIN. When you ask that question, Mr. Chairman, of any research and development man, of course he has a fixed answer. No research and development man ever has enough. That is his job—to have the imagination to see things that should be done.

Mr. BROWN. Enough what?

Chairman DAWSON. Money.

Dr. MARTIN. Enough money; yes, sir.

Mr. BROWN. May I ask you one other question?

Dr. MARTIN. Surely.

Mr. BROWN. Do you know of any other division or branch or agency of either the Government or of the Defense Establishment that ever believed or thought that they had enough money?

Dr. MARTIN. No, sir. This is part of what I said earlier, which is a part of your budget-making process. In the budget-making process, each agency wants to get the most it can to carry out its own operations, but the top management has to come to some reasonable adjustment to provide the resources that are available. I think it is even more true in research and development because the research and development man is supposed to have the imagination to see beyond the horizon and beyond things immediately before him that should be done.

So his job should be on the basis of picking the top priority job. What I really should say in answer to your question, Mr. Chairman, is that a research and development man—and I would rather put it this way—can always use more money than he has. Whether he should have more is a matter of what the balance is between the resources available. If he cannot use more than he has, then he has not the imagination to run the job. That is really the point I want to make.

One further point in this topic is the matter of expenditure limitations. I take it that this is meant to cover the limitations on expenditures that have been exercised in the last year or two in the research and development programs, which are expenditure limitations by quarter, or by month, which are below the programed level as set by the appropriations. This is the same sort of thing, although to a more serious degree in some cases, than we have in fluctuations in the appropriations from year to year. To take care of fluctuations from year

to year is bad enough, but when you have to take care of fluctuations which are unheralded within a quarter or within a month, you have to go through some rather violent gyrations to keep up with it, and that is very disruptive, both in the organization of people and the maintenance of facilities.

You cannot stop a research operation the way you can stop a building. If you discharge your bricklayers and your plasterers and masons, you can hire them again.

Chairman DAWSON. Have you found difficulty in getting capable men for your setup in the Army?

Dr. MARTIN. Yes, sir; we have. It is one of our biggest problems—to get capable people—and not only to get them, but keep them.

One thing that has been relied upon, particularly at the top level of management, is to get people to come from industry jobs to spend some time in the military organization. We have been very fortunate to get people to do that, but it is expecting quite a lot of a man who is in midcareer in an active industrial organization to take too much time out of that career because the tide goes by him while he is out of his normal activity, and when he goes back to his organization he may have lost out, or he otherwise would have gone——

Chairman DAWSON. Do you feel, Doctor, that the taking in of qualified younger men and giving them a rank in the Army with promotions in sight, knowing that their services would be used strictly for research as long as they were eligible, and once taken in they would only be noneligible because of age limitations, discharge, and so forth, do you think that would help any?

Dr. MARTIN. I think it would help; yes. I think we have to recognize that you are talking about military personnel.

Chairman DAWSON. I am talking about trying to get men into our armed services in research, and get them to stay and devote their attention to the questions involved in the Military Establishment.

Dr. MARTIN. I think you are right. I think one of our most difficult problems to take care of today in this age of specialization is to get the military people assigned to an area of specialization and to stay in it long enough.

Chairman DAWSON. Thank you.

Dr. MARTIN. And, of course, unfortunately, today for a military man who stays in a specialized field and does not get troop experience, for example, or for a man in the Navy who does not get experience with the operating fleet or with a carrier, it is considered that his career is jeopardized for future promotion to the top levels.

Mr. LANIGAN. Could I ask a question on the first point?

Dr. MARTIN. Surely.

Mr. LANIGAN. Could you give us an example or two of how the expenditure limitations have affected your operations? We had some general statements, but it has been hard to tie down any examples.

Dr. MARTIN. Well, I have one example in mind: I am sorry I did not refresh my memory on some of these things, but one of our missile jobs—the Sargeant missile—we have had to underfund and in that way delay its availability date.

With the way technology increases these days, when you stretch out a development job, you tend to make it obsolescent by the time you get it. We have tried to retrieve some of the ground we lost in that

particular case by putting more funds into it this year, but we lost ground we never can get back.

Mr. LANIGAN. Have these expenditure limitations been unexpected, in the sense that you have planned out a program for a year on the basis of the appropriation that was requested and obtained, and during the course of the year suddenly find that money is not available, although appropriated, so that you have to do considerable changing in your planning; is that a problem?

Dr. MARTIN. You have to reprogram. The only way you can cut your expenses is by stopping some things, or cutting down the activity, and what it generally amounts to is you cut your outside contracts, and that means you have passed the responsibility for adjusting to this new situation to your contractors, rather than absorbing it internally. The contractor usually has more flexibility than we have in the military organization.

Mr. LANIGAN. Of course, the classic example, I suppose, is the one that occurred last September, when there was this 10-percent cut in research and development, and then there was a restoration of that cut toward the end of October. Do you find that the restoration fully compensated for the cut, or did that add to expense and lost time?

Dr. MARTIN. I am talking in generalities, and I have no case to cite, but, based upon my experience, I am fully convinced that that does represent a sacrifice. You cannot go down and come up again in a hurry without losing something. It just does not work that way. It is not like a matter of turning a tap in a tank, keeping the liquid in the tank, and then opening it again. You are bound to have expense and confusion and loss of morale in these gyrations in a job of that kind.

The people on the job begin to wonder whether there is any stability in it, and they want to go somewhere else where they have more continuity of operation.

Mr. LANIGAN. When these limitations have come down, have you been consulted in advance, either on the amount of the limitation or how the limitation might be made effective, or do you get the limitation and have to do the best you can?

Dr. MARTIN. Your statement is correct.

Mr. LANIGAN. I assume you mean that you get the limitation and you are left to work it out as best you can?

Dr. MARTIN. Yes, sir; as best we can.

Mr. LANIGAN. And you are not consulted about it in advance?

Dr. MARTIN. No, sir.

Mr. LANIGAN. Mr. Poland has raised the question of apportionment. Do you figure out the apportionment requests, or are those figured out by the Department of Defense for you?

Dr. MARTIN. We make them out. This is out of my field and in the financial end, which I do not handle myself. They are made out in the Army and forwarded to the Defense Department who then forwards it to the Bureau of the Budget.

Mr. LANIGAN. But you do not know what the apportionment is going to be. You ask for it, and either get it or you do not get it?

Dr. MARTIN. I think, pretty generally—yes; we know what they are before they go through. We have a chance to discuss those before they are put through, in my own experience.

I might pass on to the second topic, the matter of the problems of budgeting and accounting which adversely affect research and development operations.

I have already discussed the general controversial nature of budgeting, which is characteristic. The thing we have in the defense research and development budget which is particularly serious is the fact that we have to start preparing our budget about 18 months prior to the time that the money becomes available, and, in that time, of course, a lot of change can take place. In the technical field, changes are evolving so rapidly today that, in the period required for the acceptance of the budget by the administration, the authorization by Congress, and the apportionment by the Bureau of the Budget, it takes about a year. So, from the time we really start to defend our proposals until we get the money, about a year has gone by, and a year today in the research and development program is a long time. So, we have to frequently reprogram and reallocate our programs between the time we start to develop our budget and the time we get the money to carry it out.

The next item mentioned in this outline is accounting, and here we come across a more or less age-old controversy between accounting people and people who carry out operations. That is particularly true in the case of research and development.

The accounting people put emphasis on assigning and justifying costs, which is rather difficult to do in a research and development operation. We have a situation today which I am very much involved in right at the moment as to our accounting practices with respect to research and development contracts carried out by universities and nonprofit organizations. We have some very definite regulations here as to what overheads can be charged by universities and nonprofit organizations and what fees they may get to cover the services that they give. This is becoming a rather difficult matter to adjust because conditions vary from year to year, and from university to university, and from laboratory to laboratory, and particularly in the case of the better organizations who are doing this kind of work. The better they are, the more military work we tend to push upon them. When the military work is only a small part of their total, they do not need to be too much concerned about whether they are covered, exactly, on their expenses or not, but, when that becomes an increasing proportion, that is another matter.

One of the heads of one of the nonprofit organizations called me recently and told me he was very much concerned because the military work was now becoming 80 percent of his total activity and he had to be sure to cover his expenses; otherwise, he would be running in the red.

So, I discussed the thing with our contract people and our other people, to see if we could not get a little more liberal interpretation of some of the regulations, because we do not and we cannot afford to have organizations that are good for that sort of work have to drop the military work because they cannot get their expenses back under the strict interpretation of some of the regulations.

I am not saying this in any criticism of the setup or the regulations or the people who have to carry them out, but it is a matter which we have to work out on a broad basis, particularly where we are dealing

with universities, to insure that we are not handicapping their activities by not properly reimbursing them for their total costs in carrying out our work. This goes back to a fundamental conception, you might say, that a university's buildings, for example, are all built by endowed funds. Since they are built by endowed funds, the approach is that they should not be allowed to earn anything on those investments. The university always has the option between investing its endowed funds in securities and getting a return or putting them in buildings. I think we have to give some recognition to the fact that they have this option.

One other point along that line: In allowing charges today for university buildings, they are only such as to cover the amortization of the initial investment, which, in times of inflation, of course, does not take care of reproducing those buildings when they do wear out. I mention these as illustrations, and think we have to be careful about them.

There are a couple of other topics which I think can be associated with this No. 2 item that I would like to touch upon at this time, if I may.

One of them is the matter of contracting for research and development projects. Of course, the general method of procuring things by the Government is on the basis of competitive bidding and on a fixed-price basis. I am convinced from my experience in industry, both in doing research and development work for industry and also for the military, that you cannot contract for research and development on any fixed-price basis. I think if you did and if you knew what the costs were going to be, you would not be doing exploratory work; you would be doing a routine type of activity. So, pretty generally, now our contract for research and development is on a cost-plus-fixed-fee basis, and that is the way it should be.

My own feeling is that that is the preferred way of doing research and development and that it should not be on a fixed-fee basis except where you are contracting for the services of a certain number of people for a year and where you are paying their salaries, but for real research and development you are developing new things and I think you have got to do it on a cost-plus-fixed-fee basis.

Mr. LANIGAN. We have found that sometimes on cost-plus-fixed-fee contracts that it has resulted in a contractor not being too careful about the costs that he incurs, and if he subcontracts for particular equipment, he really is not too careful about getting the best price for that.

How do we meet that type of situation?

Dr. MARTIN. You have two answers to that: First of all, we have our auditors go through their accounts. Anyone who works on a cost-plus-fixed-fee basis has to submit to inspection by Government auditors. Secondly, I think there is solution which we have not made enough use of, and that is when we find a man or organization does not do the right kind of job, we do not give him any more contracts. After all, most of these people want to have a good reputation and stay in business.

Chairman DAWSON. Or see his Congressman.

Dr. MARTIN. Well, I will not comment on that.

So, there is this matter of insuring that our ability to contract for research and development is sufficiently flexible to insure that we get the right kind, or good results, and also that we keep the people who

are capable of doing this kind of thing eager and desirous of staying in this kind of business.

Another factor that comes into this matter of funding reasearch and development is the thing that we touched upon earlier, and that is the difficulty of carrying on this work on a basis where you only know in any one year what you are going to have available for that year. We need to have what we call longevity funds which we can use to commit contracts for more than a year because most of these projects today last several years, and in order to properly program and have the work built up the way it should be from one year to another we need to know how much money we will have available next year as well as how much we will have this year. There are some steps being taken now in Defense to provide a small amount of money to the several departments to carry on this so-called longevity funding for some of their basic research problems.

Then, another matter which I consider is very, very vital today is what I would call optimum funding. In carrying on any research and development project, particularly if you are working with a competent developing agency, you can pretty well determine the maximum rate at which you can carry that job, taking into account the skills, the technology, and the facilities available, and that is the maximum rate which you can carry it on without doing things that are obviously foolish in the way of taking chances. You should not commit funds or adopt procedures that are not likely to give you the proper return. Having determined what that optimum rate is, the funding should be such as to support that optimum rate.

This is very nice to say these words, and we do try very hard to optimum fund our most important highest priority projects. Unfortunately, however, we are not able to fund enough of them on that level.

Now, one easy comment to make there is that if you did optimum fund your most important projects, all right, go ahead and do that with the money you have available and let the rest of them go. Unfortunately, you cannot go that far either, because of the thing I mentioned earlier. You have certain facilities and certain organizations which are working in fields that you know you have got to continue to work in, and you cannot drop them and destroy them and then try to build them up next year. So, there is always a large number of projects that have to be carried even though at below the proper level, and I stress this point because today the technology is moving so rapidly that if we do not fund these important projects at the optimum level I mentioned, the outcome may be obsolete or obsolescent when it becomes available.

Now, in many of our important development projects in recent years since the war, the time cycle from initiation to availability of the weapon or the system has been of the order of 8 to 10 years.

That is just too long. You have to cut that time in half, and it can be done if we get proper funding and get rid of some of the procedures that hold us up.

Chairman DAWSON. How would you secure optimum funding? Would that take more appropriations or take faster allocation of funds?

Dr. MARTIN. It means faster allocation of funds on a particular project. If you put more funds on a project this year and you are working on a fixed level of overall research and development, that means you have got to shortchange some other things or else cut them out. You cannot always cut things out and that is where your matter of judgment comes in. I think, as I mentioned here earlier, the technology today that is important and necessary in the military goes all across the board. It is pretty hard to think of any field of research and development today that does not have a bearing on the military problem which means you have to cover a large range of operations. You cannot go in and chop out large areas of the background work that you are supposed to be doing. When the funds are not available to carry out the proper level, the trend is—and very properly so in many cases—just to stretch these things out and defer the time when you have the answers.

I will pass on to the third topic, the fiscal, organizational, and operational problems arising from the centralization of control and detailed direction of research and development, including those arising in the relationships between the military services and the Office of the Secretary of Defense.

This is the thing that has been much discussed. I would like to say first of all that everybody agrees that some centralization of control is necessary in order to determine policies and coverage; that is, to insure that the various areas are covered by the developing organizations that are working in this field; and, secondly, that there is not an undue amount of duplication or overlapping.

On the matter of detailed direction this can be restrictive as to the kind of things that should be done, and in becoming restrictive it can be repressive in handicapping the people who are working in these fields. A research job, if it is really research, is a matter of working in an area to get new concepts and new knowledge. If you knew just what you were going to come up with or just how you were going to work, it would not be research. So you cannot exercise too much detailed direction in this field.

One thing that I am inclined to put stress on, based upon my own experience in industry, is that we should put more of our control of our operations in Government—and I think this is not peculiar to the Defense Department; I think it is the Government generally—on the basis of judging by results rather than trying to control by directives or step-by-step approval. This is the way we work today in industry. We give a man a job or an assignment, and at the end of the year you judge him by what he has turned out as to whether he is competent to go on. With the decentralization of responsibility which has been found to be necessary in large organizations, you have to work on that basis, and you have to give people responsibility and authority and then judge them by their results rather than trying to tell them in detail how to run the operation.

Lastly, in connection with this, I would like to make a very strong plea that in research work you have got to depend upon the people that you put in charge of it. You have to have faith and confidence in them that they are competent to do the job. You have put them there, and if you do not have confidence in them, you should not put them there. In this field preeminently the nature of the work you get de-

pends upon the people who are running it, and if you do not have trust in them you are not going to get good research work.

Chairman DAWSON. Are you suggesting that there has been too much supervision from up above?

Dr. MARTIN. Yes; too much attempt to direct the work that is being done by research management.

Mr. LANIGAN. First, I understand that at times even though a project is approved, money is doled out in a way that requires a reporting back at frequent intervals and going through a complete review process of the progress which has been made, and so on. Is that true?

Dr. MARTIN. That is true.

Mr. LANIGAN. That not only delays and causes difficulties with the working people but causes delays in the progress of your project?

Dr. MARTIN. Yes, sir. If you have that sort of a control—what I call step-by-step control—it means you work up to a certain point which you have been directed to do and report on it, and then you stop and make up your report and go through some discussion or argument as to whether you should be authorized to go to the next step. It means you are breaking your work up into discreet steps or you go forward and more or less have a hiatus and go forward again with the other step. This is a sure way of at least dampening the ardor and enthusiasm of the people who are trying to get on with some important findings in a new field.

Mr. LANIGAN. You were in the Office of the Secretary of Defense as well as in your present office, I understand?

Dr. MARTIN. Yes, sir.

Mr. LANIGAN. You mentioned your concern about competence. Do you have any reason to think that the people who are doing the reviewing in the Office of the Secretary of Defense are any more competent than the people who are doing the work and actually carrying it out? Are they really competent to contribute anything to the program?

Dr. MARTIN. Well, I have been in both places. Does not that answer it? I do not mean to be facetious. No; I do not think there is any material difference in competence between one place and the other.

Mr. LANIGAN. Do you find that after the money has been appropriated on the basis of a justified program that you have considerable difficulty and delays in actually getting that money to carry out the project which has been justified? I think General Gavin had indicated that he went up and justified a budget and then he found he was not getting the money to carry it out even though it was appropriated?

Dr. MARTIN. Yes, sir.

Mr. LANIGAN. What is the cause of these types of delays?

Dr. MARTIN. Well, there are several causes. One was the expenditure limitation that was mentioned earlier and this matter that after the appropiration had been given you there was an expenditure ceiling. I would not question the necessity for an expenditure ceiling because after all from the overall standpoint of Government you have got to make your outgo met your income. Because of emergencies that may arise in one area it will push your expenses up and you may

need to curtail your expenses elsewhere. Also, of course, the more organizations that you have to go through to get final authorization the more tendency there is for delay and also at times there is a tendency for curtailment. The successive stages of approval may look at the matter with less of an optimistic view than the first organization in the series may have looked at it, or at time, of course, those things may be entirely justified because things may have changed.

If you have authorized a project to accomplish something which no longer needs to be accomplished, then there is no reason why you should not curtail the expense as you go along. I do not think you can be categoric in saying that all of these expenditure ceilings or all of these curtailments are wrong. The man who is carrying on the job, of course, is always expecting and hoping that his project will be the one that is carried through to completion just because he wants to do his own work.

Mr. LANIGAN. How about the question of detailed review of the item itself? Does that cause you great delay? Could you give an example where you have had a delay?

Dr. MARTIN. It causes delay particularly if your authorization to take the next step is contingent upon the outcome of that review.

Mr. LANIGAN. Do you have any example that you could give that is not classified?

Dr. MARTIN. I do not think so. Most everything that I work on is classified.

Now, I might go on to the fourth item, the problems arising from the policy of a fixed dollar level for research and development in a time of rising prices and increased weapons complexity.

The comment there is really very simple and brief. A fixed level of dollars in time of rising prices and increased weapons complexity means that you do less work as time goes on because what you have to buy that work with is less and less. I mentioned earlier that the 1955 dollar is expected to be worth about 80 cents in the fiscal year 1959.

Mr. LANIGAN. Do you have a feeling that you are falling behind in the research that you ought to be doing?

Dr. MARTIN. Very definitely so. I might say this, taking into account the decreasing value of the dollar, inflation and also the matter of the increased maintenance of the facilities required to carry out the research and development work, in the fiscal year 1959 our budget is over $100 million more than it was in 1955, but so far as effective dollars to carry out research and development activities are concerned, we will have no more resources than we had in 1955.

Of course, the complexity of the weapons has gone up very rapidly in that time. So I think it is very obvious, even though our budget figure is up, we can really accomplish less results.

Mr. POLAND. Would you comment upon the allegation that a large part of the applied research money is buried in production contracts?

Dr. MARTIN. I would not say it is buried. Do you mean by "production contracts" just to turn out equipment?

Mr. POLAND. The allegation is made that a great deal of applied research is done in the course of production, so that it does not appear in the budget as a research appropriation but becomes a procurement appropriation.

Dr. MARTIN. I think that I would have to qualify a little bit your question if I may. It is customary today—and I think it is pretty well known—that in carrying out the research and development program, procurement money is used to buy the test vehicles, the items that are used for test and evaluation; they are paid for out of the procurement funds.

For example, with regard to the big missiles, in order to get test vehicles you have to pretty well establish your production design and get production tooling so you are really working both for research and development and production at the same time. In building the said vehicles they are many times being made for doing what might be called applied research in order to perfect a design of the test vehicle. So, to that extent, there may be some work done that might be called applied research. It is more in the nature of engineering or development, but I would not say that it would necessarily be buried there.

I might go back to explain better what I mean. Take the work that has been done recently on the reentry problem of missiles coming into the atmosphere at high velocities. You can say that is applied research today because you are trying to find an answer to a particular design. If we had done it 5 or 10 years ago, it would have been basic research because we did not have any devices to apply it to at such time, so the nature of the work may be the same today as it was 5 years ago, but it would be called basic research 5 years ago and today it might be called applied research, or development.

Mr. POLAND. I will extend my question to include development.

Then the inquiry would become clear as to whether or not the development expenditure in research and development is so incorporated in procurement that it militates against your receiving sufficient research and development funds specifically so designated.

Dr. MARTIN. No, I do not think so. I think that you have to recognize that these things are not clear cut at the time. For example, you may go through into production and have a device that has some weakness that comes out in the use of it. Then you will want to go back and change that. The research and development work may be terminated, and what you are doing is modifying an existing design that is in production. It may be just as important to modify that at that stage as to have made that modification back earlier in the research and development. So there is not any clean point at which you can say research stops, development stops, and production begins and goes on. These three things are bound to be overlapping and should be.

Now, our next item is No. 5 "Utilization of the results of basic research in weapons development."

The purpose of basic research, primarily, is to have available a reservoir of new concepts and new information, new technical information. By having such a reservoir when you take on the job of determing how you should develop a device for a new purpose, the bigger that reservoir is, the more extensive it is, the better opportunity you have to pick the right answer on how to go ahead. That means that your likelihood of picking the right answer or procedure is better, and also the time required to carry it through is likely to be less long because the more background knowledge you have the less likely you are to run into bottlenecks in areas where you do not have enough infor-

mation to know how to proceed and you have to stop and do some applied research, or development, in order to get the job back on the rails again.

So the big advantage in having a wide range of basic research is to be always in the position of making wise decisions as to how you should proceed to make progress and meet any particular need that comes up.

Mr. LANIGAN. What techniques do you have for converting basic research into weapons development; how do you know that the people who shape the military requirements and develop the weapons are aware of the things in this reservoir of basic research?

Dr. MARTIN. Well, the only way you can do that, or the way that I would do it, is to have people who are expert in doing just that thing—people whose business it is to know what is coming out of technology in the way of research, and who are also exposed to the requirements and needs of the operations in the military. This is a very important group of people in the whole procedure. The skill with which they can appraise both fields and match up the potentialities of technology against operational needs determines how wise you are in selecting the ways of meeting these needs. There is an increasing recognition of the importance of this skill in the research and development operation. As a matter of fact, in the organization of which I was a member before I came to Washington, 10 percent of the scientists and engineers in the organization were engaged in just this process.

Mr. LANIGAN. Do you have people in the Army engaged in this process?

Dr. MARTIN. Yes.

Mr. LANIGAN. Is there a sufficient ratio in the right places?

Dr. MARTIN. No. I would not say that there is a sufficient ratio. This field is becoming increasingly important because with increasing technology and increasing needs for the military, and the necessity for being economical in carrying on this work, and also the necessity for cutting down the time cycle that I mentioned earlier, the field of systems engineering—which is this activity that I just described—is being recognized as being of increasing importance. And the organizations in industry that have recognized this and have built up organizations of this kind are the kinds of organizations we want to be the prime contractors for our big jobs because they are in a position to know how to plan their work properly. Unfortunately, today we do not have enough organizations in the country who are organized on this principle. That is my own opinion.

Mr. LANIGAN. Does not the problem of military and civilian turnover enter into this picture? Where you have a rotational system where there is a large turnover the new people just normally would not know.

Dr. MARTIN. Turnover militates against the stability of any kind of an operation, this one as well as any other. Fortunately, here we have people who are skilled both in the civilian and the military parts of the military organization, and also many of our contractors have great strengths in this area. That is being built up because of the pressure of necessity for it.

The sixth point we have already touched upon, the problems involved in retaining competent personnel. One obvious comment there is that more remuneration would be very helpful, but also more confidence, as I mentioned earlier, in our people and giving them more responsibility and authority. This applies particularly to the upper levels of the organization, the higher echelons, as they are called, to insure that we are getting the maximum contribution from these people by recognizing their ability and giving them comparable responsibility and authority.

I think another big factor here is the flexibility in salary treatment we have in the positions that Congress has increased a number of recently, the so-called Public Law 313 positions, or more recently, Public Law 1028's, where the positions have a salary running from $12,500 to $19,000. We can make the salary for a position not only dependent upon the position, but also the competence of the man in the position. I think this is a very important factor in the technical area.

The comment that I would make generally on the civil-service setup is we have a means of treating people that has to cover too wide a range. It covers everybody from the lowest laborer to the blue-collared worker to the white-collared worker and on into what we think of as the upper white-collared group.

Today we should recognize that two people on the same level in an organization have different competencies, and we have to have some way of rewarding that, and also have an incentive that is not dependent solely upon longevity. So I welcome the flexibility that we are getting in these positions. I think that Congress has just authorized about 150 more of them for the military department.

Mr. LANIGAN. Is there not quite a problem in determining who is competent and who is not?

Dr. MARTIN. That is not unique. I would not say that that is too much of a problem; no. It is a thing that we are faced with in every operation. I have been spending a lot of my time in my life trying to determine how competent people were in order to determine what salaries to give them.

Mr. LANIGAN. Do you think that you can make those decisions stick in a governmental atmosphere?

Dr. MARTIN. Well, we have had some experience with the Public Law 313's. We have not had many of them so far. I think the Army today has 35 of them. That number will be more than doubled by this recent legislation. I am personally trying to bring about in the Army in the utilization of these positions this concept that I mentioned—that salary is not determined solely by a position in the organization, or by length of service; that it can recognize also competence and promise of competence.

We have the situation that promising young people are welcomed these days in a lot of places, and if we cannot give them promise of growth they will go where they can get the promise of growth. That is the thing that I like to hold out, that you can give a man one of these Public Law 313 assignments and he can realize that there is a top available there that is higher than in the regular civil-service grades. I think that that has a big effect. It is not solely what a man gets in direct remuneration today; it is what he can hope for in the future that has a big effect in determining his stability in his position.

We have another factor that comes into the matter of stability of the civilian personnel in these research and development jobs, and it comes down to the duality of management by both military personnel and civilian personnel. It is customary in many of the military laboratories to have a military man, a top man, and under him civilians. Well, the military man may be subject to rotation every 2 or 3 years, and the civilian people are sometimes very much upset because of the shift in competency that may result in a rapid turnover of the top people. This, I think, is a factor that has been given a lot of discussion and attention.

The seventh point is areas in research and development where effort should be concentrated to minimize serious waste of funds through duplication, unwise development, and other causes.

This is a very large subject. I think, however, I can treat the high spots of it briefly. One thing I think we need to recognize here is that in talking about research and development we are talking about two phases of a cycle which are quite different in the way that they should be handled.

The word "development" should be broken down into two phases—exploratory development, and specific or design development. I will define what those terms are.

We are trying to meet an operational need for the military people for a new device, a new weapon. We undertake work to find out how to meet that need. This is what we call research and exploratory development. That stage is largely paperwork or experimental work, and here we should have more than one line of approach. We should have several lines of approach. We might have approaches in each of the 3 services, or more than 1 approach in any one service, or more than 1 contractor. This is where we should be liberal in allowing competition and promoting competition, even to the extent that there may be some duplication.

In research, just because two people are working in the same field does not mean that they are doing the same work. What you want to do here is to explore all of the possibilities, or likely possibilities, that may give you a good answer. So here I say we ought to promote and encourage competition and possibly duplication.

After you have gone through this exploratory stage and determined the feasibility of several lines of approach to the problem, then you should make a decision, and this is a hard decision to make. Out of these various lines of approach that you have followed, not necessarily what is the one best one, but out of all the factors in these several approaches, what is the best combination to go ahead with. Having made that decision, now you are talking about a project to develop a design of a particular device to be produced and used. Here is where you want to be very careful that you are not encouraging or promoting or allowing duplication, because here is where the spending of the money becomes much larger. You are building things. You are cutting hardware. You are getting tools and building facilities. So you just cannot say do not have competition in research and development, or have it. You have to divide the thing into two phases, the first phase where you want competition, and the second phase where, in general, you do not want it.

I want to qualify the second phase somewhat. In certain areas where the outcome is of the utmost importance to get an answer by a given time, you may well, in the interest of assuring that you get your answer by that time, have competition or duplication even in the second phase. I should say there the case should be very clear and strong for that kind of a dual approach to be authorized.

Mr. LANIGAN. The point there is that that competition should be planned and realized, not accidental.

Dr. MARTIN. What has happened at times—and this applies in various areas—a research and exploratory project is started to find out how you can do something. You may start three of them, for example. If you do not have wise supervisory people who know how to appraise these performances and make suitable decisions, the tendency is to let all three of them go on to the hardware stage. Then, having gotten into the hardware stage and put money into tools and facilities, somebody might say—why stop any of them, the money has been spent, let us carry them on. So, as a result you have a complete duplication right down to the use stage. This is the thing that we want to guard against. It means that you have to have competent management and supervision to properly appraise the situation as you have gone through the exploratory stages to say—this is the procedure from here on. Stop some of these things and go on this one track.

One more factor in carrying out this kind of procedure, as I have indicated, is to have good project managers, that is, to have a supply of good people, competent people, who know this procedure; who are skilled in technology and who are not afraid to make a decision. There is no replacement for that. That is a matter of being able to get and retain good project people on each of these major projects.

Chairman DAWSON. Would it be a civilian usually?

Dr. MARTIN. It could be either. There is no distinction between the civilian and military in this area. The major factor in the case is military continuity. There have been cases I know of where, in important projects, we have been able to keep a military man on the project until the job is done because of its importance. We have abrogated the rotational procedure.

Another very important factor in cutting down the time cycle that I mentioned earlier, the development cycle, is to carry on the development of the thing to be produced in such a way that the thinking of the producing people and of the using people can be incorporated into the development of the design. That means that the man developing a new thing to be produced has a manufacturing engineer working with him so that what he designs can be produced economically and in quantity with proper quality. While he is developing his design the production man should be determining what tooling he is going to use; what processes he is going to use.

Another factor that we have to recognize here is that in this development cycle, as I have termed it, we also have not only a head of the development cycle, but also interspersed through it, the procedures involved in getting authorization and funding. Those are time consuming.

Mr. LANIGAN. Do you think there is definite room for improvement in the Defense Department in these factors you have mentioned in connection with No. 7?

Dr. MARTIN. I think that there is room for improvement, and I do not confine it to the Defense Department or the Army or the Navy. I would spread it also across the country in all of these factors, and learning how to do these jobs more speedily and making greater use of technology. There are certain techniques today that are available that can be very helpful. There are also organizational matters and the matter of insuring you have good project people, for example. Progress is being made. I do not mean to give any idea we are not making progress. We are.

The eighth item is the nature and results of research and development work performed overseas.

We have recognized for many years and decades that people overseas in many areas are just as competent, particularly in the basic research field, as we are in this country. As a matter of fact, until recently we have drawn upon the people in Europe, the smart people in Europe, for a lot of our basic research. Today in the military organization we are drawing upon the skills and the facilities that are available to us among our allies and friendly nations. All three services have organizations in Europe that are placing contracts with universities and industrial organizations. It is a field that is very important and one we plan to build up, not only in Europe, but probably in other areas where we can get work done by that kind of people. It has obvious other advantages in addition to the information that we get out of it.

We are making the people of these nations feel that they are more of a partner in our activities by having them join with us in our basic work. Of course, the development of the program that we are carrying on with the friendly nations in developing the mutual weapons development program is quite extensive. So I think there is a very strong and concerted effort to make use of the thinking and skills of our friendly allies.

The ninth item is the effect of military requirements on scope of research and development.

As I mentioned earlier, the military requirements for new devices today reach into, and derive support from, practically every area of research that you can think of. I find it pretty hard to think of any area of research that is active today that we are not interested in in the Army, and I think the other services also.

So in carrying on the military work that we are fostering and helping, we are benefiting by the reasearch program across the board, whether it is in physical sciences or the social sciences. Also, in turn, the more research work that is carried out across the board, the more information we have as to new things that we might develop and find uses for.

Mr. LANIGAN. We had Dr. Berkner here as a witness. He advocated that there be a civilian organization separate from the Department of Defense, somewhat possibly along the lines of the old Office of Scientific Research and Development. He pointed out that certain concepts, such as the Navy night fighters, the DUKW, the amphibious vehicle, and the proximity fuse, and I suppose even the atomic bomb all were originally thought of entirely outside of the military hierarchy. The problem is that if all of our militarily oriented research is done under the Department of Defense is there not a chance of some

of these other very valuable contributions being missed? Could there be a division in the National Science Foundation, or a separate office, to handle entirely unthought-of concepts, or radical concepts?

Dr. MARTIN. I am very familiar with this proposal in this line of discussion. I did a lot of work for the Office of Scientific Research and Development during the war, and I am aware of what they did and what a fine job they did, and the kind of people that were in it.

There are two factors that I think need to be taken into account in carrying over the appraisal of what was done in that organization during the war, and I say this in no way of being derogatory of the organization. They did a fine piece of work.

We have two factors that are quite different today than what existed at that time.

At the beginning of World War II, the military people had not been very aggressive in pushing technology. The general concepts were that the previous methods of fighting wars were the kind that would be used in any future war, and also there had been very little interest in the advance in technology for that purpose. There had not been much support for it. So the Office of Scientific Research and Development came into a situation where the military had not been aggressive in advancing technology for military purposes. It was a big field to move into and bring about new devices. I was responsible myself for developing some of the things that the Office of Scientific Research and Development put out.

Today, however, during the war and since the war, the military people have learned the benefits of research and development and technology for their purposes, and I do not think that there is much need today for stimulating the military thinking along the lines of the importance of these things. And the mere fact that we have this continued urging by the military organizations for more and more research resources to carry out research and development I think is a very strong indication of the change in thinking on the part of the military people.

So that need, I think, has been well taken care of by what has happened in the military organization.

The second point is that, during the war, under the emphasis of the war and the call for sacrifice on the part of everybody, you had a number of most competent people working in the Office of Scientific Research and Development at very little, or no, compensation. They were willing to make great sacrifices in order to carry on this kind of an activity. You could not get that number and kind of people today to work in a civilian organization for the kind of remuneration they got. Their returns then were a matter of patriotism, the result of doing something for their country, and they were willing to sacrifice everything else in order to get that. You cannot get, in peacetime, that kind of sacrifice as a means of carrying on a job of this sort. So, while you can get people for a short time who are willing to make sacrifices in order to carry on this kind of activity, they will not be willing to do it in sufficient numbers. That is my thinking. You cannot get sufficient numbers to make such an organization function effectively for a period of some duration.

Since the war, as a result of the recognition by the military of the importance of technology, you have a number of very close relation-

ships with outside scientists, both in universities and in industry, who are acting in an advisory capacity, consulting capacity, to the Department of Defense and all through the military services, and to the various agencies and the laboratories within the military. So, we are not depending by any means solely upon the military technology or upon the technology of our contractors, but also on a very large group of voluntary technical people, scientific people, who are giving of their time and advice to the military. I think the present situation is entirely different from what it was when OSRD did its fine work during the war.

Mr. LANIGAN. How about research into factors of cold warfare, such as economic warfare and psychological warfare? Do you think that there is a need for centering that somewhere and stimulating that type of research?

Dr. MARTIN. Cold war is outside of my responsibility in the Army, but, speaking as an individual, I think there is a great deal that is there for research and development into the factors involved in what we call cold warfare because there we are talking about the use of political factors, economic, sociological, psychological. In fact, every contact any person inside this country has with other countries, whether it is a tour, a business transaction, or discussion with people outside, they could all be a part of our cold-war activities.

What we are talking about here is really a matter of how to get other people to accept the things we think are proper, in order for the world to live at peace and prosper in the future. This is an enormous subject. It deals with human relations and international relations. I feel there is an enormous amount of help that we can get in that area from research in the fields that are underlying these areas.

Mr. LANIGAN. Where would you suggest that be centered?

Dr. MARTIN. It is a matter of national policy.

Mr. LANIGAN. It would not be in the Department of Defense?

Dr. MARTIN. The Defense Department has one area of operation which causes some confusion along the line of your question. We have what we call psychological warfare, sometimes called special operations. But the responsibility of the military in psychological warfare is confined to combat areas in times of combat; that is, the military do not have any mission or responsibility outside of such areas.

Now, there is one more point, the 10th point, the lessons to be learned from conduct of industrial and other research.

There are a number of points that might be mentioned here. I will confine myself to a few, some of which have already been mentioned.

One is in a research and development organization, the segregation of the long-range research and exploratory work. We discussed earlier here that research work may extend throughout the various periods of the development cycle. I found, from my own experience, in carrying through a development you may be called upon at various times to stop and do what would be called basic research if you had a lot of time to do it. If you put together the long-range work and the work of settling matters that come up day by day, as always happens in any operation, the day-by-day problems take precedence over the long-range problems and the long-range problems do not get done. So, I think one basic factor in our long-range exploratory research and develop-

ment work is that the groups responsible for that should be separated out and not, as you put it a while ago, buried within the interstices of other processes. You can then definitely know who is responsible for the long-range work, what facilities they have, who they are, how much support they are getting, so that you can keep supervision over what they are doing, and whether they are being properly supported, and whether they are being properly productive.

Of course, having such an organization, you must give them adequate support, both in resources, facilities, and personnel.

Another thing that I mentioned earlier is the matter of giving greater responsibility and independence to the people who are running our research and development operations and not try to direct them too closely. Let them have more control of what they are doing, so they can broaden their activities and also develop themselves to a greater degree. Of course, in order to do that, you have to have skilled personnel in these positions to whom you can justify giving such responsibility.

In industry, as in budgeting and funding, you can get speedier authorization, speedier orientation, which may mean increasing or decreasing activities as the occasion may demand.

Another factor in running a research and development operation: the top management who have to do with determining what is being done with the money made available should know also what is not being done, so that the top management which determines the resources are a party to the decisions as to what things are being left undone. I think this is almost as important in many cases as knowing what is being done. Top management also should understand, foster, and have respect for research and development operations.

Mr. LANIGAN. That has not been the case in the Defense Department? There is more room for that?

Dr. MARTIN. I do not think that you can make a categorical statement like that. It comes down to a matter of individuals. What I am saying is, this is a very important factor. There is a tendency today, not only in Government but also in industry, to support research because that is the thing to do—everybody says that you must do research. You find lipservice being given to it in many industries. They have a research department, but in many cases it is not much more than an inspection organization. What I am saying is, in order to get this thing in focus for support, the people who are providing the resources have to believe in it, have to want it, and have to respect it, and not do it just because it is fashionable and somebody says they have to do it.

Mr. POLAND. Would this be a fair conclusion from your testimony: that, in the field of basic research, and perhaps somewhat in exploratory development, the project is largely a subjective matter, depending a good deal upon the personnel of those who conduct it? They might go by different routes to the same goal, or, perhaps, might even arrive at a different goal.

Dr. MARTIN. Yes.

Mr. POLAND. That area is largely a subjective area, and it only becomes an objective matter when it comes to the program management and you are looking to put these things together to determine the precise applicable result.

Dr. MARTIN. Well, I think that is a very good statement, but I would like to go a step further. I think in this area you have to be both objective and subjective. You cannot have any organization run solely objectively or subjectively. What you want is a proper balance that can be flexible enough to give the subjective area its proper support when needed and not have the objective area overwhelmingly control the subjective. We are getting into a sort of philosophical discussion, but I think it is an important thing that goes beyond the organization chart. It comes down to people and people's thinking and how they treat these things.

I sometimes think of it as a matter of leadership versus police action. You have to have a certain amount of police action in any organization, but you do not want to have that become the dominant thing. You have to have leadership in any organization, but you have also to recognize there are times for the policemen to come in. The success of many operations depends upon the proper balance between these two. You can get the fellow who is all out for the subjective, criticising the fellow who is objective, and the fellow who is objective criticising the fellow who is subjective. You can call it what you will, whether it is the accounting man or the financial man against the idea man. It comes down in the last analysis to a proper balance between the two, call them what you will.

Chairman DAWSON. Thank you very much, Dr. Martin. Your contribution has been very gratefully received and will serve a good purpose. I do not want you to feel that because so many members had to be absent upon this occasion that your presence was not appreciated. We are carrying on a continuing study of this matter, and we have gotten out one previous document, the background and testimony on this question of research, and we are finishing up another phase of it. Your testimony today has been a very fine contribution. I marvel to see how you agree with other scientists and other departments on some of the things that could be done to improve our basic science and research and development programs in the different services. We are very grateful to you and the members of this committee will go over your testimony and evaluate it in the light of the other testimony.

Dr. MARTIN. Thank you very much, Mr. Chairman.

I might say, as you probably know, this is an activity that I have been in all my life. I have been trying to improve research and development procedures and results, and that is why I am in Washington today.

Chairman DAWSON. I am wondering what we can do to keep up with the Russians, or pass them and stop this cold war. I think that scientists are very necessary. We did not think much of them in my youth. They occupied a different place, but today it seems they have come into their own, and they are very much needed. Now we are worrying—do we have them available and can we use them in such a manner as to retain leadership in world affairs? We must retain it in order to exist, in my judgment.

Dr. MARTIN. I heartily agree with that, sir.

Chairman DAWSON. The committee will stand adjourned until 10 o'clock tomorrow.

(Whereupon, at 11:45 a. m., the subcommittee adjourned, to reconvene the following day at 10 a. m.)

RESEARCH AND DEVELOPMENT
(Part 2—Military Research Representatives)

FRIDAY, JULY 18, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION OF THE
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m. in room 1537, New House Office Building, Hon. William L. Dawson (chairman of the subcommittee) presiding.

Present: Representatives Dawson, Brown, and Fascell.

Also present: James A. Lanigan, associate general counsel; Milton G. Johnson, professional staff member; William A. Young, staff consultant; Elmer W. Henderson, subcommittee counsel; and Lawrence Redmond, subcommittee clerk.

Chairman DAWSON. The subcommittee will come to order.

We have with us today Dr. Paul D. Foote, Assistant Secretary of Defense.

STATEMENT OF DR. PAUL D. FOOTE, ASSISTANT SECRETARY OF DEFENSE (RESEARCH AND ENGINEERING), ACCOMPANIED BY BEN HUFF, DIRECTOR OF REVIEW AND SERVICES

Dr. FOOTE. Chairman Dawson, I am very pleased to meet with this committee. Before I left on this trip to San Francisco I had a chance to look over your letter and the 10 points that you have raised. I did a little work on sketching my position on those points. I have that material with me. I also have a biographical sketch with me, since this is the first time I have appeared before your committee.

Chairman DAWSON. Thank you. It will be placed in the record at this point.

(The sketch referred to follows:)

BACKGROUND AND EXPERIENCE OF DR. PAUL D. FOOTE, ASSISTANT SECRETARY OF DEFENSE (RESEARCH AND ENGINEERING)

I was born in Andover, Ohio, on March 27, 1888. I received a bachelor of arts degree from Western Reserve University in 1909; a master of arts degree from the University of Nebraska in 1911; and a doctor of philosophy degree in physics from the University of Minnesota in 1917. In 1953, an honorary doctor of science degree was awarded to me by the Carnegie Institute of Technology.

From 1911 to 1927, I worked with the National Bureau of Standards, starting as a laboratory assistant and serving from 1924 to 1927 as senior physicist. From 1927 to 1953 I was director of research for the Gulf Oil Corp. and was executive vice president and a member of the board of the Gulf Research & Development

Co. from 1933 to 1953. From 1945 to 1953, I was vice president of the Gulf Oil Corp. and of the Gulf Refining Co. Late in 1953 I resigned all positions held with the Gulf Oil Co.

From 1954 until my nomination as Assistant Secretary of Defense (Research and Engineering) on August 16, 1957, I was active as a consultant to industry on general problems in research management. During a portion of this period, I was Chairman of the National Academy of Sciences Advisory Committee to the Office of Ordnance Research, Department of the Army.

I am a fellow of the American Association for the Advancement of Science; fellow of the American Physical Society and past president; member of the National Academy of Sciences and Chairman of the Engineering Section; member of the Washington Academy of Sciences; the Optical Society and past secretary and editor; member of the American Philosophical Society, at present secretary; member of the American Institute of Mining and Metallurgical Engineers, the American Geophysical Union, the Rheological Society, and the American Ordnance Association.

Dr. FOOTE. I have with me Mr. Ben Huff, who is Director of my Office of Review and Services.

Our biggest problem, I suppose, in the fiscal, budgeting, and accounting matters—which is probably what you are more interested in than any other thing—is not in the budgeting and accounting procedures, but rather the very difficult problem of determining how best to use the large sums of money that we have for research and engineering which have been appropriated by the Congress.

For example, in 1959 it is $6.2 billion.

Taking up some of the subjects that you have listed, I think items 1, 2, and 4 are so closely related that I would like to discuss them together.

On the effect of year-to-year changes in moneys appropriated, I think it is generally agreed that a fairly level, steady program in research and development provides a greater payoff than a program with short ups and downs, or one with a crash program content.

We must maintain constant military research and development programs by exploring all research frontiers and insure a steady flow of superior weapons. To accomplish this also means a steady flow of funds without sharp peaks and valleys.

That is true in industry, too. I had 30 years of experience in directing industrial research. I believe we have maintained a steady flow of funds for this important work.

To illustrate this point I have a table that I would like to quote from, which shows both new obligational authority and expenditures from research and development appropriations for the fiscal years 1947 to 1959. Do you want me to read those figures?

Chairman DAWSON. Proceed.

Mr. FOOTE. I will just read the expenditures.

	Million		*Million*
1947	$515	1954	$1,385
1948	534	1955	1,391
1949	608	1956	1,491
1950	539	1957	1,686
1951	758	1958	1,838
1952	1,164	1959 [1]	2,323
1953	1,412		

[1] Estimate.

There is a gradual increase with a rather sharp increase in the last year.

Now, on the effect of rising costs, there is no question that rising costs have affected the research and development effort, but this has been at least partially offset by greater selectivity in the development of items, improved management by wider use of experienced research management teams, and the increased support of funds from the procurement and production type of appropriations which form an integral part of the larger research, development, test, and evaluation program.

I believe that your committee staff has been provided with copies of a study conducted in my office which adjusts the availability of research and development funds by applying a research and development index.[1] This study points out it now takes $1.60 to buy $1 worth of 1950 research and development. That is an increase of 60 percent. This, of course, does not take into consideration the increasing support of procurement and production type funds which amounted to $1.8 billion in the fiscal year 1955 and climbed to $3.3 billion in 1958.

The continued support of these funds and the vigorous application of the two management principles listed above should enable us to offset the rising cost problem. We think that we are getting more efficient in managing research all the time.

Mr. BROWN. May I interrupt to ask a question? How much actual control and authority do you, as Assistant Secretary of Defense in charge of research and development, have over the research and development activities in the various branches of the armed services?

Dr. FOOTE. Well we have the complete final say-so on all programs supporting appropriation requests.

Mr. BROWN. Do you have the final say-so on spending, and what programs shall be followed, in the various branches? I am speaking now with regard to research.

Dr. FOOTE. Yes; we have to approve. Of course, in such a large field of research I have to rely upon the technical people in the services. We do not attempt to direct the details of how research shall be operated, but we do supervise the general program and if we see one subject is being neglected we discuss that with the people involved and say, "You had better cut this one field and increase the field that looks particularly promising."

Mr. BROWN. We receive information—and perhaps I should say reports rather than information—from time to time here on Capitol Hill that the different and separate branches of the armed services are working on the same research subject. Do you have any control over that to be sure that the Army, the Navy, and the Air Force, for instance, are not doing exactly the same thing, where one research study might be sufficient?

Dr. FOOTE. Yes. As a matter of fact, I think that has been much overemphasized.

Mr. BROWN. Has there been any justification for these things?

Dr. FOOTE. Well, there is duplication. In general, I feel the duplication that we permit in the research field is very desirable. You want all of the ideas possible in the early stages of research.

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[1] See chart 1.

Now, for example, let us take the B–52. The curve for developing and paying out on a finished product starts out at a very low rate and then it reaches a maximum several years later and then as you phase out it dies off. Now, the total cost of the project is the total area under that curve, plotting years against dollars. The total research cost is very trivial. As an example, I just happen to recall in that one incident $70 million was spent as a total for research. The expenditures for the development and procurement to date are $4.8 billion.

Mr. BROWN. You mean on the B–52?

Dr. FOOTE. Yes, showing that research is a very small part of it.

Mr. BROWN. Excuse me a minute. I think that you have wandered away a bit from my question.

In connection with this research on the B–52, did just the Air Force conduct that research, or did the Navy, the Air Force and the Army research agencies all work on it?

Dr. FOOTE. Well, I would say they utilized the work in research of all the services as developed by contractors in general.

Mr. BROWN. In other words, where it was beneficial?

Dr. FOOTE. Yes.

Mr. BROWN. That leads to my final question, which I think we ought to have on the record.

There have been reports brought to Members of Congress at different times where one military agency would develop some weapon, or make some breakthrough on research that they did not always quickly share with the other agencies of the Defense Department. What can you say about that? Do you have any evidence of that?

Dr. FOOTE. I have seen no evidence in the short time that I have been in charge, but I understand that complaint has been made. It looks to me now as if the closest cooperation between all of the services is carried out. We have daily meetings with the representatives.

Mr. BROWN. You feel that the rivalry, so-called, between the different branches of the armed services has not affected the research and development program?

Dr. FOOTE. Not in the research and development area. In the procurement area I think probably it has.

Mr. BROWN. Yes. We have found that so in the past, that in the procurement area one agency would be buying something at the same time the other was selling it.

Dr. FOOTE. Coming back to these kinds of curves, if I could draw a curve here to show what I am getting at——

Mr. BROWN. I think that I know what you mean, sir.

Dr. FOOTE. Here [drawing curve] is your research down in this little bit of the area. If, by putting a little more money into research and having duplication you can get some ideas that will cut down on this part of the curve [indicating] you might get a curve that looks like this [indicating], and you would save all of this later cost by doing a little more research. That is why I am encouraging duplication in the research stage.

Mr. BROWN. As soon as this duplication of research bears some fruit you want that fruit made available to all interested agencies immediately, and that we do not continue dispersing our effort when not necessary among different operations.

Dr. FOOTE. I am absolutely confident that it is pooled and that all information on any subject is exchanged.

Mr. BROWN. Promptly?

Dr. FOOTE. Promptly.

Mr. LANIGAN. Would you consider the present development of the Thor and the Jupiter missiles by the Air Force and the Army a duplication in research, development, or procurement?

Dr. FOOTE. A duplication in procurement. That project should have been stopped. Both of the weapons are good, there is no question about it, but we cannot develop everything that comes out of research; therefore, you have to make decisions at some point and say—we will develop this and stop another one. That is out of the field of research. That is after it has passed the basic research stage.

Mr. LANIGAN. At what point should it have been stopped?

Dr. FOOTE. Well, I am not familiar enough to state, but it is evident it should have been stopped sometime ago.

Mr. LANIGAN. I have been told that for practical purposes the Thor and the Jupiter are similar weapons serving similar missions and they actually have almost similar components, but the difference has been in the management of the construction of them; is that correct?

Dr. FOOTE. I presume that is so; yes.

Mr. LANIGAN. Then in the case of the Jupiter satellite, the Army satellite program, and the Navy satellite program, do you consider that to be duplication in research, or development, or production?

Dr. FOOTE. I would say that it was too early to make a decision there in that field. I think that is in the early stages of development.

Mr. LANIGAN. Was that in a stage where one should have been pushed or the other, or do you think it was proper to have both developments going on at the same time?

Dr. FOOTE. I think in that case they both should have been encouraged.

Mr. LANIGAN. Will you state for the record why that is so?

Dr. FOOTE. Well, we are in a sort of crash program to get some results. I will admit when you are in a crash program and the whole object is to get results immediately, it is more costly than pursuing it at a low level, but that is what we are in for and therefore I would encourage it in that partticular instance.

Mr. BROWN. If you will permit, I would like to ask another question or so before I leave.

As I understood the answer to counsel's question, and to my question previously, you do believe that there should be a cutoff on some of this research and a swing into development as quickly as possible. What about development? Do you think that there should be some cutoff on that so that you can go ahead with the production of weapons?

Dr. FOOTE. Yes, you have to cut off development if you have two parallel things. There are plenty of instances where you have two parallel developments and one should be cut off.

Mr. BROWN. Now, let me ask you another question based on this statement: During World War II we received numerous complaints from industry that it never could get the military to decide what they wanted; that when they would start to manufacure something somebody would change the color of the vehicle and many times, in my

opinion, make stupid changes that would delay production but would not increase the fighting effectiveness of the weapon, of the use of it in battle. As a result, there were long delays in the delivery of needed goods to the Armed Forces.

Does your agency, or your division, have anything to do in following through once that development is completed and say this is it, and produce enough to where it is worthwhile?

Dr. FOOTE. That was long before my time.

Mr. BROWN. I know. You are not responsible for what happened in World War II. I am asking what the policy is now.

Dr. FOOTE. The policy now would be to recommend decisions.

Mr. BROWN. And then go ahead with your production?

Dr. FOOTE. Yes.

Mr. BROWN. Because after all, in the end, what we are interested in, and the American people, I think, is the production of these worthwhile weapons that we need at the earliest possible moment and the supplying of them to our Armed Forces.

Let me ask you another question. How much of the funds which are appropriated for research and development for the various branches of the armed services are used to equip new plants and move them here and there, or to change formats, and how much is actually used for research and development? Can you tell me that? I base that question on the situation which arose here when the Assistant Secretary of the Air Force was before us in connection with the moving of the research and development center from Wright-Patterson to an office building in Baltimore that was inadequate in every way, and from there over to Andrews Field, and from Andrews Field they had to move a lot of people out to Illinois, and then from Illinois they had to move other people to San Antonio, Tex., and so on and so on. As a result, to my knowledge—and that was all done over the opposition of the officers and the others in charge of the research program—it delayed research and development and has brought about a situation where now you have duplication. You have more people on research and development at Wright-Patterson than you had before, and you still have this other setup out at Andrews Field, and there has been a lot of public money spent.

Now, Congress has intended this money for research and development and not to move somebody around, regardless of whether those in charge of the program think it would be helpful or harmful.

We have had another situation that did not come before this committee, Mr. Chairman, but it did come before our Committee on Rules, and then we turned it over to the Armed Services Committee to investigate, and that you read about in the paper—at Indian Head out near Washington. The Government began to close down a $200 million installation at Indian Head, and take thousands of people off the payrolls and transport them to some place else—or they had to get new employment—and then went out and spent money to do the same thing, and to develop new facilities, on the west coast for the same research and the same work.

Does your office keep close check to be sure that these other branches of the armed services really use good sense and judgment in such matters?

Dr. FOOTE. I certainly think the $2.25 billion that has been appropriated for research and development is spent for research and development. I do not think any of the funds come out of that appropriation for that.

Mr. BROWN. Regardless of whether the dollars are actually taken out of this little pot marked "Research and development" to move these different research and development facilities here, there, and yonder, or whether it is taken out of another pot marked "General funds," does not make much difference. It has an injurious effect, all of this moving around, on the overall research and development program, and on top of that, regardless of why you take the money, in the end it comes out of the hides of the American taxpayers. Most of the Members of Congress have some interest in trying to protect the taxpaying public from the misuse of their funds, or from waste and extravagance in Government. I wonder if you people check that closely.

Dr. FOOTE. I am certainly checking it and I have been for the last year. Take, for example, this Indian Head proposition. I have had my men down there investigating just how Indian Head can be saved. They do not have the competence——

Mr. BROWN. Neither did this new agency that was built out on the west coast until they got competent people.

Dr. FOOTE. That is right, but they do not even have the space facilities.

Mr. BROWN. I am sure that with a $200 million investment in the facilities at Indian Head we had more space out there—and I have seen Indian Head—for research and development work than you have in this new plant, the one I know of in California costing $10 million. It just seems to me when $200 million was expended on Indian Head some years ago they got more for their money in space than you could get now for $10 million under the present conditions out in California, which is a high-priced territory.

Dr. FOOTE. They were equipped to do a certain line of work. It is a very difficult thing to convert, for example, a chemical plant from doing one thing to doing an entirely different thing.

Mr. BROWN. I understand that, but I also understand out on the west coast they were not equipped to do it either, or to do anything. You just newly equipped them. So it would not take any more money, and not as much, to reequip the buildings in the plant you own now at Indian Head as it would to build a new building and do the equipping new.

I wonder how closely such is being watched. I want to urge you, as one Member of Congress and of this committee, that you do pay special attention to that, because I can assure you Congress is going to watch it very closely in the years ahead.

Dr. FOOTE. We are recommending this be made a research and development center for solid fuel work. We do not believe it is possible to convert it into a production facility. That is our opinion in the research and development field.

Mr. BROWN. I wanted to get that in the record.

Dr. FOOTE. We are watching it very closely, and I have had several very competent chemical engineers down there seeing just what could be done. It is a tough problem.

Mr. BROWN. I understand that, but I hope to impress upon you the feeling of the Congress on these subjects and the desire of the Congress that these matters be watched very closely and that we spend our money on research and development, regardless of where it comes from, rather than spend it on new buildings and facilities when we have old ones. That seemingly goes on constantly.

Dr. FOOTE. Well, we have a great many of those problems.

Mr. BROWN. I understand that.

Dr. FOOTE. They are always threshing them out.

Mr. BROWN. If you want problems, come up and serve in Congress for a while. You will get your full portion, I am sure.

Mr. FASCELL. Then, as I understand it, your recommendation with respect to Indian Head will make it unnecessary to follow out the Navy's decision to close it down?

Dr. FOOTE. I do not think the Navy has finalized that decision at all.

Mr. FASCELL. If they had such a decision your recommendation would change that?

Dr. FOOTE. Well, they do not intend to shut it down entirely. They simply say that it cannot be used.

Mr FASCELL. For a particular purpose?

Dr. FOOTE. Yes.

Mr. FASCELL. And you are giving them a new purpose?

Dr. FOOTE. Yes.

Mr. FASCELL. As a matter of fact, if you found no new purpose for research and development, you would not have anything to do with Indian Head. The only reason that you are investigating it is to determine whether or not you can use it?

Dr. FOOTE. That is right.

Mr. FASCELL. So it has nothing to do with overriding the Navy's decision in the first instance?

Dr. FOOTE. No. Secretary Norton has been very interested in salvaging everything possible down there.

Mr. FASCELL. In other words, the Navy facility is about to become available, and the research and development branch of the Department of Defense is determining whether or not they can use it. That is the present status, so far as you are concerned?

Dr. FOOTE. Yes.

Mr. FASCELL. And you are recommending a use?

Dr. FOOTE. Yes.

Mr. BROWN. If the Navy cannot use it, then why should not some other branch of the military use it?

Mr. FASCELL. By all means.

Dr. FOOTE. I agree with you there; it should be utilized jointly by the Army and the Navy as a research and development area, and I think that can be arranged. That is the talk now. That was only last week's opinion.

Mr. FASCELL. It belongs to the Government?

Dr. FOOTE. Yes.

Mr. BROWN. And it belongs to the people of the United States, and they are not too much interested which branch of the armed services may use it, just so it is used for the benefit of the people.

Mr. FASCELL. Mr. Chairman, I brought up that line of questioning to make it clear that the Assistant Secretary of Defense for Research

and Engineering has nothing to do with overriding a Navy order. I doubt very much that that could be done under any circumstances. In fact, we have had testimony before this subcommittee on other matters that the Secretary of Defense could not override an order of the Secretary of the Navy. I just wanted to be sure that we were not getting Dr. Foote into some kind of a dilemma.

Dr. FOOTE. We do no attempt to override anybody. We are asked, as we are in all problems, to furnish information that will help the Navy, or any service, to make a decision.

Mr. FASCELL. I would like to ask some other questions, if I may. I am interested in what your policy is today with respect to the emphasis on basic research. I heard you testify in answer to certain questions from Mr. Brown. I am trying to correct, I hope, what is my misconception.

Dr. FOOTE. Well, I am sure that there are plenty of examples that can be presented to illustrate the role of basic research in advancing weapons systems and making possible revolutionary breakthroughs into new defense concepts. Basic research is the one source of knowledge leading to ideas for unconventional weapons for the military. The classic example is the development of nuclear weapons only 6 years ago, or rather, 6 years after the fission of uranium.

Some of the other examples are geodetic and atmospheric data. We need all of that information for the ICBM and the AICBM work and guidance; large computers and operation analysis techniques for strategic planning in war games. We are even working on a synthetic concentrated liquid diet for space travel, anything to feed people in a space machine. Also radio telescopes for navigational purposes and data on magneto hydrodynamics. That is one of the most difficult subjects in physics right now in the application of controlled thermonuclear reactions. We have done a tremendous amount of transistor work for the miniaturization of electronics. We have been responsible for the development of many new materials, titanium, which is becoming more important every day. Also, the silicons, high-strength steels, plastics, metals, and liquids not susceptible to gamma and neutron radiation and high-temperature materials.

I suppose the most important field today in research, basic research, is new concepts of materials. We are absolutely floored in everything we want to do by the capability of materials to perform. We want to push the temperature that steel or ceramics can stand. We want to push it 50° if we can. Those are very difficult things to do.

We need new breakthroughs in all the fields of materials.

I have urged the increase of funds for basic research in this field.

In this last year, the fiscal year 1958, by the use of transfer authority to the emergency fund, we have augmented the basic and supporting research programs in a substantial way; $31.6 million additional were made available for important and highly critical work in the physical, medical, and geophysical sciences; $10 million were made available for basic work in the field of materials; $12.5 million were provided for essential work in electronic tubes and electronic parts. Thus we have raised the level of basic and supporting research from $85 million to around $140 million.

Now, not only that, all of these drafts on the emergency fund were made to the services on condition they would finance them out of their own planned programs for subsequent years. These are commitments that will run over a 5- to 10-year period.

Now I want to emphasize that, in basic and supporting research, we seek to encourage duplication, or parallel approaches to the solution of any problem. Hence, we want all the ideas we can get. Duplication here is highly desirable and relatively inexpensive.

However, when we reach the development stage, we must select the best approach and terminate unnecessary duplication.

As we approach the hardware stage, we must make a choice, however difficult, because we simply cannot afford to carry into production several types of weapons designed to accomplish the same purpose.

Let me give you an example from my past experience of 30 years in the oil industry. I suppose that we developed 10 or 15 different refining methods, any one of which was a payout to the company, but it was obvious that the company could not finance or capitalize every one of those programs, even though they would pay out. Therefore, they had to make selections, and decisions were made. You want several possibilities for management to make decisions on, and the research people come up, for example, with 12 different schemes, all of which are good payouts, and management will say, "We can finance 2 of those and we will carry through 2 to completion." That is the way that industry manages to capitalize research.

The Government can do exactly the same thing, but it takes somebody to make these decisions. That is one of the objects of my Office. We are trying to make decisions.

Mr. FASCELL. Does that mean that your Office is a central point for the three services with respect to all programs dealing with basic research and application thereof?

Dr. FOOTE. Yes. This decision-making business is tough, as you all know. Two or three decades ago it was easy enough for an administrative officer to make a decision in science, but science has been growing at the rate of 6 percent compound interest. That means that the volume of the materials available doubles every 12 years, and it has been doing that for many, many years.

In the field of airplanes, for example, the number of possible decisions today in the construction of an airplane is over 100 times as many as in 1945.

Now, another example—there are 100,000 scientific journals published in the world. There are 300 abstract journals just to abstract the material in those 100,000 journals. It is obvious when you come up with ideas for some development there are so many decisions to be made that you must have operations research and competent channels to pass on an opinion to get it down to a manageable minimum so that an administrator can make a decision. That takes time, and the practical people in the field object to it. They say—these decisions take time—but if you want decisions, you can get a messenger boy to make a decision. What we want to do is to make the best decision, and we cannot make the best decision without going into operations research and serious consideration from the technological point of view.

Mr. FASCELL. As I understand it now, you have had an increase in funds dealing with basic research for the past year?

Dr. FOOTE. Yes.

Mr. FASCELL. And we can assume from this that you will apply the same emphasis with respect to those funds in the coming budget year?

Dr. FOOTE. That has been agreed upon by the services.

Mr. FASCELL. Now, you say that you are the focal point for all projects of the three services with respect to basic research and applications?

Dr. FOOTE. Yes.

Mr. FASCELL. And that you favor, as a matter of scientific and practical policy, duplication on basic research?

Dr. FOOTE. Yes.

Mr. FASCELL. Therefore, this presumes that there must be the most complete intermingling of ideas between all teams working on a basic research problem?

Dr. FOOTE. And I think that is true.

Mr. FASCELL. And so you can tell us today that if the Army, the Navy, and the Air Force are working on the same basic research problem, the scientists who have been assigned to that work have complete freedom of interchange of ideas?

Dr. FOOTE. Yes; they have symposiums and meetings all the time.

Mr. FASCELL. All right. Now, because of the fact, as you have very well pointed out, decisions are complicated by the vast amount of science and the modern technological stage we find ourselves in, it has become necessary if you are going to take the basic research which has any value and apply it to some military purpose that the decision be made at the earliest practicable time as to which direction you are going to take in the application of the theory; is that not true?

Dr. FOOTE. I would say so; yes.

Mr. FASCELL. Therefore, as you run into a situation where you do not have complete interchange of ideas among scientists who are assigned to each of the three military services, who are working on the application of a theory, this might be very injurious to the concept which you have; is that not true?

Dr. FOOTE. It would be, but I do not think that condition exists.

Mr. FASCELL. In other words, you are testifying today and telling us that on devlopment we have today complete interchange of ideas between men who are assigned to the various projects in the three services?

Dr. FOOTE. Yes; I am sure of that.

Mr. FASCELL. And there is no danger that one service would develop a plan, or operation to a point where there would be no turning back from their particular application before you had any ideas from either one of the other two services?

Dr. FOOTE. I do not see how that could arise. If I thought there was any incident of that kind I would immediately call a meeting of the other services and inform them.

Mr. FASCELL. I am sure you are aware, of course, that one of your predecessors in this office had that difficulty—and that this was a very, very different thing to overcome.

Dr. FOOTE. I think the services have seen the handwriting on the wall and have decided it is feasible to cooperate.

Mr. FASCELL. That is certainly encouraging.

Mr. LANIGAN. According to the figures which your office has supplied to the committee on obligations for research and development, and adjusted them to the 1946–49 index figures so that we can have a comparable comparison over the years, the research and development in the Army dropped 33.8 percent between 1952 and 1955 and between 1952 and 1958 it was down 25.1 percent.

In the Navy we have a drop between 1952 and 1955 of 44.2 percent and between 1952 and 1958, 26.6 percent.

In the Air Force it went down 19.4 percent between 1952 and 1954—that is 1 year—and 17.9 percent between 1953 and 1958.

Overall, your research was down 30 percent between 1952 and 1953 and 1955, or on the basis of your own adjusted figures, a drop of $1,179 million to $824 million between 1952 and 1955. Between 1952 and 1958 it had gone down 22.7 percent, or from $1,179 million to $910 million.

We had testimony in addition to the rising costs and the fact that weapons are becoming more complex and that research is needed more than it was when weapons were more simple. In connection with this, Assistant Secretary Horner of the Air Force testified that the Air Force was supporting basic research he thought at a proper level, and he thought they were supporting development, immediate development, of weapons for immediate use properly, but he said there was a large area of what he called technical development of weapons which would be for use in a period of from 2 to 5 years from now and he said that we do not have adequate support at the present time for this technical development area and we will either have greatly more expensive development in the future to catch up because of this lag, or we just will not have the weapons we need in 2 to 5 years.

The figures do show research lagging behind, and in the light of Secretary Horner's warning, and Secretary Norton's warning—and Secretary Norton also felt that research was lagging behind the needs of the military—I am wondering how you can say that we are getting along fine and then our only problem is managing the money we have. Is there not actually a problem of getting the money you need for research and development. You are in charge of research, development, and engineering.

Dr. FOOTE. I certainly agree with that, that no research man is satisfied with the existing appropriations. I can assure you that for every dollar that is appropriated we see places where $10 could probably be spent. Certainly the appropriations could be doubled and we could spend them wisely, but I do not follow all of your statement there. Would that include the depreciation of the dollar—those figures?

Mr. LANIGAN. The figures that I read relate to the amounts of money that you are appropriated and the effect of the depreciation of the dollar on those amounts. You testified that it costs $1.60 today to buy what it cost you $1 to buy in 1950.[1]

Dr. FOOTE. You took this table that I read and readjusted it?

Mr. LANIGAN. That is right. You read the dollar figures and I read the column on the adjusted figures in terms of a constant dollar index.

Dr. FOOTE. Relative to 1950?

[1] See chart 1.

Mr. LANIGAN. Yes.

Dr. FOOTE. Well, that is probably true, from the period 1950 on, insufficient money was spent and that is probably the reason why there was a major increase made for 1959. You see that the jump in 1959 is quite substantial.

Mr. LANIGAN. I do not have the 1959 figures. Our study was limited to the year 1958.

Dr. FOOTE. The research funds were increased in dollar value. I think that you have made a good point. I want to go into that when I get back. Maybe I will use that information as an argument for getting a little more. We need it.

Mr. LANIGAN. Do you feel that Secretary Horner's fears of the lag of weapons in the period 2 to 5 years in the future is a real danger that we have to consider today?

Dr. FOOTE. I would agree he is correct in that. That is one reason why I have been doing everything possible to increase what you might call applied research of a very fundamental nature in electronic tubes, electronic parts, and new concepts in radar. For instance, the phased array radar which may have possibilities.

Mr. LANIGAN. Do you think if we do have a boost like you mentioned we are having in 1959 that that will result in more expensive research.

Dr. FOOTE. I do not think that jump is big enough. It is not so big but what it can be taken care of by the existing research facilities of the Nation. Now, I would favor increasing each year by 3, 4, or 5 percent over that.

Mr. LANIGAN. From your experience in the military since you have been there, would you say that in the light of the more complex weapons that we need a constantly greater percentage of our total overall military budget for research; do you think that we can leave research at a constant percentage of our military budget?

Dr. FOOTE. I would favor increasing it percentagewise as well as in absolute value.

Mr. LANIGAN. Could you tell us why?

Dr. FOOTE. Simply because I feel it is so important I think by spending more money on research you will save money in procurement. In fact, I know that to be the case.

There is nothing so expensive as finding in the middle of a procurement development that it is not functioning right, because you failed to do a piece of basic research. We are getting into that trouble every day.

Mr. FASCELL. What effect, if any, on this concept, Dr. Foote, does the Russian position in the state of the art—that is, basic research and its application—have on your thinking?

For example, I might just add this: One of the leaders over there has said "Give us 5 more years, and it will not make any difference what you discover."

Dr. FOOTE. You mean one of the Russians?

Mr. FASCELL. Yes, sir; they take the position, and until the contrary is proven, I will have to give him some credit for the statement that they are so far advanced in their technology that in 5 more years in its application it would be impossible for us to catch up in a great many fields. He did not identify the fields.

Dr. FOOTE. Well, I think, on the average, we are up to them and in many areas ahead of them, but there is no question but what they are accelerating at a more rapid pace than we are.

Mr. FASCELL. Just because of budget and manpower, or both?

Dr. FOOTE. Well, I guess they do not have any budget problems, and the manpower is what they are developing in their educational system.

Mr. FASCELL. What I am trying to determine is whether or not you are going to be satisfied with what you do as an individual, mind you, realizing, of course, that you have to fit everything you do into budgetary requirements and superior policy requirements.

I am wondering whether or not you as an individual will lay out a plan which you feel is absolutely essential and leave for somebody else the decision of whether or not it will be tailored into budgetary requirements or policy requirements.

Dr. FOOTE. We are working with the Science Foundation and with Dr. Killian's group at the White House on exactly that proposition. That is, he has asked us to prepare what we think could be accomplished from a program standpoint if we had no fiscal restrictions, and we have laid out a program for 10 years on that. It about doubles the amount of research that we are now doing.

Mr. FASCELL. That is very good news. I am happy to hear that. This entire review operation will be taken into consideration in the presentation of the next budget request?

Dr. FOOTE. Yes; that is, we have asked all the scientists in the services to assume that they had no budget restrictions, what do you think could be accomplished in 1959, 1960, 1961, and so on year by year by programing and then we, of course, work out the dollar value of that, and, as I say, in 7 or 8 years from now it just about doubles what we are spending at the present time, and that is the rate that the scientists in the services would like to increase.

We also worked out a plan as to what the scientists thought they could get and that was a little less.

Mr. FASCELL. Who will establish the priority system on this? Will your office do that?

Dr. FOOTE. I think we will do it cooperatively. We are working cooperatively with the Assistant Secretaries of the services.

Mr. FASCELL. Then I assume that what you will do after you get all of this projection is to divide it into groups of things that are urgent, those that are extremely necessary, and those which are desirable, and so forth?

Dr. FOOTE. Yes, sir. All of these things will be applied eventually on a priority system. This particular study was made on a discipline system; that is, how much should we be spending in electronics and how much more should we be spending in hydrodynamics and things like that.

Mr. LANIGAN. I had one question on Indian Head, which came up incidentally, if you will bear with me, Mr. Chairman.

Chairman DAWSON. You may proceed.

Mr. LANIGAN. This has to do with the decision to place the contract for the procurement of the fuel that Indian Head might have produced with the western firm rather than producing it at Indian Head. Was that affected by a policy of procuring supplies from

private industry rather than having the Government to produce them?

Dr. FOOTE. I am not familiar with how they arrived at that decision in production, but I would think that they considered the feasibility of whether it could be done. In general, in all these production problems we first consider whether we can do it in our own arsenals, and if it looks like we cannot, then we go out for bids.

Mr. LANIGAN. In this case you have no information about it?

Dr. FOOTE. No, sir.

Mr. FASCELL. Mr. Chairman, I have one final question here.

Chairman DAWSON. You may proceed.

Mr. FASCELL. Doctor, getting back to the discussion with respect to the complete interchange of ideas between scientists and personnel assigned to basic research projects and applied developments, now, do I understand by your testimony in which you said that we had complete interchange and freedom of discourse, and that it is no longer necessary for a scientist or a person attached to one of these projects to get service security clearance in each of the services?

You see, in the past, Doctor, it was necessary for a person working on a project in the Army in order to discuss with another person on a similar project in the Navy to be cleared both by the Army and the Navy and then to have a definition of the area within which he was going to discuss before he could get permission to do so. We had considerable testimony that this was quite an unnecessary drag.

Dr. FOOTE. I would think so, but I could not answer that question.

Mr. FASCELL. Well, you will agree, will you not, that if there is impedimenta in the way of complete interservice integration of ideas dealing with at least basic research that it ought to be removed?

Dr. FOOTE. I sit in daily conferences with the Army, Navy, and Air Force and civilians, and judging by their uniforms, they are completely mixed up in highest secrecy discussions. Somebody must have cleared them.

Mr. FASCELL. I do not know what the practice is today, frankly, but I know what it was not too long ago. At one time you had to have security clearance in each one of the military department programs, in Atomic Energy Commission programs, and you had to have clearance each and every time in a new area in which you wanted to engage in discussions.

Dr. FOOTE. I think there are some technicalities when we get into the AEC work.

Mr. FASCELL. I just wanted to be sure that we had the record clear, and that there was no misunderstanding of what you meant with respect to freedom of discourse and interchange of ideas because there is considerable restraint, by way of necessary security.

Dr. FOOTE. Well, as I say, every day we are discussing top secret problems, and there are plenty of people from the three services, and civilians, in on those discussions. How they get in I do not know, because I have nothing to do with that.

Mr. FASCELL. It might very well be true at your level, Doctor; what I am trying to point out in this little discussion is that down the line somewhere it might not be true.

That is all I have, Mr. Chairman.

Dr. FOOTE. You are probably right. I am not competent to judge.

Chairman DAWSON. Who would be responsible for that condition,

and who could cure it, in your judgment? You represent all the services.

Dr. FOOTE. I supposed that everyone who had the need to know got this need.

Chairman DAWSON. "Had the need to know?" Who determines when a person is entitled to know? You are all engaged in research in each of the departments, and when a man working in one department cannot communicate his ideas with a man working in another department down on the lower level——

Mr. FASCELL. He can, Mr. Chairman, if he has been properly cleared, and if he gets permission to do so. That is the whole point. This can be done very quickly in some cases, and in some cases it takes a great deal of time.

Chairman DAWSON. Now, how can we eliminate that lag in time?

Dr. FOOTE. I am not familiar with these security matters, but let me have Mr. Huff discuss it, please.

Chairman DAWSON. Mr. Huff, will you please identify yourself for the record?

Mr. HUFF. My name is Ben G. Huff, Director, Office of Review and Services, Assistant Secretary of Defense, Research and Engineering.

Chairman DAWSON. You may proceed.

Mr. HUFF. I understand from Congressman Fascell's remarks that he is talking about the scientists that work for the Army, Navy, or Air Force.

Now, each employee of the Government is cleared before he can look at classified materiel. There are several degrees of clearance, either secret, top secret or he might have a "Q" clearance which lets him go into the atomic energy field.

Let us assume he has top-secret clearance. That does not mean he can see all the top-secret documents or reports that exist, or are created, but if he can show that he has a need to know in connection with the work he does, it is a very simple matter for him to get hold of that report.

So, I do not see that this is a problem within the Department of Defense.

We have had some difficulty outside the Department of Defense in our Armed Services Technical Information Agency. There are some people who think they are entitled to the documents, but they do not have the proper clearance and neither do they have the need to know. That is a separate problem.

I think Dr. Foote was addressing himself to the internal problem in the Department of Defense. If there is any difficulty as between scientists of the Army, Navy, or Air Force, exchanging information of a classified nature, the only difficulty would come in the area I just described. If he had top-secret clearance and demonstrated the need to know, there would be no problem in getting access to the particular document or report.

Mr. FASCELL. That is certainly true and that has been the policy, but the question is whether or not Dr. Foote in carrying out this integrated, coordinated control program from his office—whether or not it would not be better, for example, to have across the board clearance and to have "need to know" eliminated.

In other words, it takes up much time and energy. I do not say it should be done completely and in every case, but the thing I am pointing out is that the system for interchange as just laid out on the record does exist and you have to work in this atmosphere all the way down the line, particularly on basic research.

If you have three competitive projects in the same line, it is very difficult to determine what kind of integration and freedom of discourse you have under those conditions.

Do you know whether or not you are getting the best results that Dr. Foote is after?

Mr. HUFF. May I speak to that?

Chairman DAWSON. Surely.

Mr. HUFF. With respect to basic research it is seldom that that material in the early stages, and until you get to the report stage or to the actual report itself on basic research, which is a technical report, I think even security people will agree that a good deal of that material is not of a classified nature.

Mr. FASCELL. You mean it should not be?

Mr. HUFF. Well, it is not, and it is not classified always in that area. I think we have a good deal less of a problem. The problem I think is to get people together at the right time. You have spoken of the sergeants and the scientists and engineers and down the line. The problem there is more to get them to use it properly, I think the mechanism exists, and I do not know of any bars that prevent agency interchange of information at that level. I do not know of any, but there may be some, but I have been into it quite thoroughly in connection with my work with Dr. Foote. I do not think we have a real problem at that level. I appreciate that the security people administering the security program tend not to take calculated risks, and usually the programing people would like to see them be a little more relaxed. But we appreciate they have a problem. If you have got to live under a classified system, you have to go by the rules as they apply. When it runs beyond what is necessary, you have a problem.

Mr. FASCELL. That seems to be the case because we have had considerable testimony before another subcommittee of this committee, and I am sure you are completely aware of that.

Mr. HUFF. I think we have made some improvements, and we are working on it all the time.

Mr. FASCELL. As I understand your testimony and as the situation stands today, you are satisfied that with respect to basic research you have practically no impediment because the material is not classified, and therefore this makes it possible, does it not, for a contractor in basic research to exchange information and ideas with another contractor in basic research?

Mr. HUFF. If it is an unclassified document; that is right.

If it is a classified document, then the contractor—if he is a defense contractor——

Mr. FASCELL. I am not talking about the ultimate document which is produced as a result of the contract. I am talking about during the course of the work.

Mr. HUFF. Who produces the report? That is the case, I think.

Mr. FASCELL. I know if a basic research project itself starts out as a classified project, the contractor cannot talk with anybody without permission. That is the whole point. Obviously, when he produces his work and lets it out in a document, there may be some reason to classify that document although frankly I am wondering whether or not you should classify a basic research document unless it has some military application information in it.

This is what I am trying to find out now. In other words, Dr. Foote, on all new basic research projects do those projects start out with the contractor being classified, and if so, why? I am not asking for an answer; I am posing the question.

Dr. FOOTE. I can say that very few do, but there are some very basic research projects that have the highest top secrecy classification for the reason that our whole weapons system today depends upon the results of that basic research.

Now, possibly, you know what I am driving at.

Mr. FASCELL. I would not quarrel with that at all as long as we are satisfied with the major effort being made in the field.

Dr. FOOTE. I am not permitted to discuss that in an open session, and certain types of basic research cannot be disclosed for security reasons. However, I would say of the actual projects that 99 percent are open and aboveboard—not in dollars, but in number of projects, because these secret ones that I am talking about involve very high costs.

Mr. FASCELL. All I was interested in was determining whether or not the situation had changed measurably today with respect to the classification of the project initially in a great majority of the cases so as to give the contractor freedom with respect to discussion and interchange of ideas on a basic research contract.

If the record is clear that today in the major cases dealing with basic research the project initially is not classified, but that, perhaps, the end document might be classified in some cases, and that initially projects are classified in some special cases but they are exceptions rather than the rule, and then we have an understanding of what the situation is.

Dr. FOOTE. A large part of the basic research is conducted in the universities and in the university atmosphere. I could conceive of a basic research being done in an industry where they would not want to release that information until they had applied for a patent on the application of it.

Chairman DAWSON. The patent would belong to them although the work was paid for by the Government?

Dr. FOOTE. Yes, sir; on all research work contracts the patent belongs to the individual.

Mr. HUFF. But the Government has a right to use it.

Dr. FOOTE. The Government has a free license.

The Government has a free license under it if it has been financed by the Government.

Chairman DAWSON. You may proceed.

Dr. FOOTE. Well, we have not begun to cover the 10 points.

Chairman DAWSON. We may not get to cover them, but the information that has been developed has been very needed information, and very informative information.

Dr. FOOTE. I might review a little bit with reference to item 8 which is the nature and result of the research and development work performed overseas. I have a great deal of material on that, but I will just give you a bird's-eye view of some of it.

We have the European contract offices maintained by the military departments with the Air Force in Brussels, the Army in Frankfurt, and the Navy in London. They support basic research and exchange scientific information, and they fill the gaps in basic research in the United States.

Now, as of March 1958, there were 87 contracts at a total of $4.5 million. We are considering the expansion of this work to Central and South America and the Far East.

In the mutual weapons development program it mobilizes and coordinates European scientific research and speeds up new item development and speeds results and data for the United States.

I have just recently returned from Frankfurt and Brussels, looking into the work there, and I have been very much impressed by the high quality of our men that are stationed there who have access to all the European universities, and they are welcomed.

The current participants in the mutual weapons development program are Belgium, France, Norway, the Netherlands, the United Kingdom, the Federal Republic of Germany, and there are further extensions under consideration.

In the first 5 years there were about 150 projects at $150 million from the United States and originating countries on about a 50–50 basis.

In other words, the countries matched us dollar for dollar.

Completed items now in production are available to other free nations. Some examples are the lightweight tactical strike fighter for NATO, the Air Defense Technical Center at The Hague, where they have completed the communications system extending the DEW line through Europe to Turkey or are working on it; the wire-guided SS10 and SS11, or French antitank missile, which is something like the DART; antisubmarine weapons devices, new radar, aircraft-guided missiles, electronic devices, lightweight jet engines, rockets, and propellants, new munitions, and so forth. We are particularly interested right now in some of their solid propellants, especially in France. They have some very good chemists. I can go into a great deal of detail on this. Would you care to have me go into a little more detail on this general work?

Mr. LANIGAN. May I make a suggestion?

Chairman DAWSON. Surely.

Perhaps, Dr. Foote, you could submit that for the record, and we could include it, rather than having it read.

Dr. FOOTE. All right; I will do that.

(See p. 438, infra.)

Mr. LANIGAN. Mr. Chairman, may I ask the witness a question?

Chairman DAWSON. Yes, sir.

Mr. LANIGAN. I had not realized that you were through with your presentation on the budgetary items. I had 1 or 2 other questions on that.

The committee has been informed that each year in the course of the beginning and the preparation of the budget, guidelines go to

each service from the Assistant Secretary for Research and Engineering indicating the amount to be budgeted for research and development by each service. This guideline is a separate item from the general overall guideline that each service gets.

Could you tell us with reference to your office how these guidelines are made up; that is, to what extent do you actually set the figures yourself, and to what extent are you required to divide up the kitty among some figure that you are given on the overall budget?

Dr. FOOTE. These amounts requested are in general 50 percent more than what is finally allocated even temporarily. Now, after final allocation a dollar value is assigned to each service, then they try to program those dollars on the various activities that they want to take up in Research and Development. They frame up their program and submit it to my Department. My Department then goes over those projects, major item by item, say, through 20 or 30 different major items.

Mr. LANIGAN. You initially furnish them with a guideline?

Dr. FOOTE. Yes, sir.

Mr. LANIGAN. How is that guideline made up in your office?

Do you have some figure that you are given from someone else or do you get it up yourself?

Dr. FOOTE. I do not think we have a figure.

Mr. HUFF. May I speak to that?

Dr. Foote has not been in office long enough to be involved in this procedure as yet.

Mr. LANIGAN. Surely.

Mr. HUFF. The procedure has not always been the same. As a matter of fact, I have only been in this area myself since last November—that is, the research and development appropriation—but it has been done differently in different years. The President and the Bureau of the Budget and the National Security Council have a good deal to do with establishing an overall figure for the Department of Defense, and then you finally get down to the research and development program effort, dollarwise, and there is a tentative overall level determined.

Mr. LANIGAN. The question I am trying to get at is who determines these matters?

Mr. HUFF. A whole group of people are involved in it.

Dr. Foote, as a matter of fact, for fiscal year 1960 will be involved in it in a big way. Very shortly now, of course, the Secretary of Defense and the Deputy Secretary of Defense, the Comptroller, the National Security Council, and the Director of the Bureau of the Budget. All of those agencies are involved in it.

When it gets down again to the research and development appropriation, per se, Dr. Foote will be right in the councils when this is determined. As a matter of fact, he does not know this yet, because he has not been back long enough from his trip, but we have in preparation in his office a guideline paper which he has not seen as yet. The dollar figure that will eventually be in there is yet to be determined, but, according to the schedule that we have with the Bureau of the Budget for fiscal year 1960, there are definite target dates in there to accomplish each step in the business between now and August 1 or August 15, and we expect to arrive at some sort of a figure.

Dr. Foote will certainly be in the middle of that.

To answer your question, the determination is made in council really with the Secretary of Defense, Dr. Foote, and everyone else that has an interest in the research and development effort.

Dr. FOOTE. I sat in last fall when the 1959 budget, as an observer, was being considered, and they had the representatives of all the Secretaries, their assistants, and all the active top officials in the services. They sit down—and as a matter of fact, these were Saturdays and Sundays for several weeks during September—and they argue on what shall be cut and what shall be emphasized, and finally out of this general conference they arrive at figures for so much research for the Army, Navy, and so on, and for all the other activities; how much for payrolls for the services, and all of these things are taken under consideration at these joint conferences, and then when the sums are finally fixed, we go over the items by classification. They first follow our guidance paper which is now being prepared and which I helped on in the rough draft, but I have not seen the final draft, apparently. It will go back to the services, and they will follow our recommendations as far as they can.

We may recommend that more emphasis be given on a certain subject even at the sacrifice of dollars in another subject. That is argued back and forth until finally a figure is eventually agreed upon between the services and our Department.

Mr. LANIGAN. One of the problems that a number of the witnesses spoke to—in fact, I think every one of this week's witnesses spoke to it—is the problem of getting the money so they can utilize it after an appropriation has actually been made. There were some complaints that there were delays in the apportionment procedures, and in other cases there was a reference to a limitation of expenditure which had been made particularly in the last year.

Now, according to the information which the Department of Defense has supplied to the committee, the Navy states that the various actions of the Comptroller had the effect of withholding $50.5 million from the Navy by the Bureau of the Budget in fiscal year 1956, and another withholding by the Navy Controller, which was later rescinded. There was also a statement that in August 1957 the Secretary of Defense ordered the research and development effort in effect lowered by 10 percent by charging to research and development certain costs that had not heretofore been charged, and they say that this necessitated the cancellation of 254 Air Force research and development contracts.

The Army reported that it was unable to fund any research and development with new funds in the first half of the year and had to stretch out 1958 ground movement projects.

The Navy furnished a list of—I do not think, perhaps, I had better read off the names of each one—11 contracts that it had to either delay or cancel, and in the case of the Navy they point out that the added cost amounted to several hundred thousand dollars.

What part does your office play in the course of these apportionment problems and expenditure limitations? Do you actually participate in that, or is that done by some other office?

Dr. FOOTE. We participate in it; yes, sir.

Mr. LANIGAN. Could you tell us what is your experience with this type of difficulty; that is, in getting money to use after it has been appropriated?

Dr. FOOTE. I know that the tendency of the operating people is to criticize the Comptroller and the Bureau of the Budget, but I will say this: I have known many Comptrollers from my work in industry, and I have never known any Comptroller as brilliant and as thoroughly competent as Mr. McNeil. I would rather have his advice than the advice of many scientists, to tell you the truth.

When you are up against a retrenchment policy, as they were at the close of 1957, you have to follow the rulings of these fiscal people, and make the best of it. Of course, it hurt research, and it hurt all of us. When it was rescinded, we were, of course, delighted, but when it was rescinded it meant spending more money and it meant increasing the national debt. You simply cannot maintain the debt limit and not suffer from making cuts in our various departments, and I do not think you can blame the Bureau of the Budget or blame the Comptroller for these cuts that are ruled necessary.

Mr. LANIGAN. Then it is from a policy that is set above, by the Bureau of the Budget?

Dr. FOOTE. I would say it is a policy that comes from the National Security Council and the President, himself.

Mr. LANIGAN. Do you participate in the National Security Council's consideration of research expenditures and research budgets?

Dr. FOOTE. No, sir; I have not gotten into that field. Mr. Huff says my predecessors have, but I have not been called in yet.

Mr. LANIGAN. And you have not had any personal contact with that operation?

Dr. FOOTE. No, sir.

Mr. LANIGAN. That is all, Mr. Chairman.

Dr. FOOTE. Would you like to consider item No. 3, "Fiscal, organizational, and operational problems arising from the centralization of control and detailed direction of research"?

Chairman DAWSON. You may proceed.

Dr. FOOTE. Any fiscal, organizational, operational, or relationship problems that we face from time to time do not arise because of the centralization of control and detailed direction of research and development. For example, the major fiscal problem that we have is to make sure that the large sums of money appropriated are used wisely. Also, even though we are requesting the sum of $6.2 billion for our research and engineering programs for fiscal year 1959, this sum will not take care of all the work proposed by any means for research and development. Therefore, we have to exercise selectivity, and selectivity of the very highest order.

With respect to the organizational problems, many difficulties that we have stem largely from the sheer size and complexity of the Department of Defense research and engineering effort.

With respect to relationships with the military departments, I know of no serious problems that have arisen. However, there are times when honest differences of opinion arise with respect to certain projects and programs. Now, these differences of opinions are natural to expect, and there is no way that they can be entirely eliminated, nor do I feel they ought to be eliminated. It is only through full discussion of controversial programs, where huge amounts of money are involved and where the security of the Nation is involved, that we can arrive at sound decisions.

The job assigned to my Office is, first, to provide the broad policy direction and guidance to the military departments and joint agencies under which they develop the detailed policies and plans for the execution of their individual programs. We do not try to tell them how to do a thing.

Secondly, we conduct a continuous review of the Department of Defense research and engineering programs. Now, obviously, the Secretary of Defense must have some organization to advise and assist him in the highly important area of research and engineering since he could not give it adequate attention in view of his many other responsibilities.

Sometimes, as a result of our review of the departmental program, delay—or what is called a delay—occurs. I mentioned that before, and it is because you have to have competent people to consider it, and that takes a little time.

I know of no case where any so-called delays have resulted in lack of progress. More frequently, any delay caused by our review has resulted in a better final solution or decision.

Secondly, my Office does not exercise detailed direction of research and development; rather, we try to give the best guidance we can and apply the best judgment we can, particularly to the major programs, but as specifically how they shall do the work, why, that would be impossible.

As a matter of fact, to give you an idea regarding the administration of research alone, today, Admiral Bennett has 525 people administering the details of the research program that he supervises. Well, we cannot have any organization like that in the Department of Defense. We have to utilize Bennett's opinions and the opinions of his men on the type of research that he is in charge of, and the same thing is true in the Army and Air Force. They have highly competent men, and even the arguments that we have are always among highly competent men.

Chairman DAWSON. Is there anything else?

Mr. LANIGAN. I just want to get to this point: There seems to be the general complaint or statement that there is too much detailed direction, and I suppose that is an arguable point whether there is or is not. But one of the devices which is said to be used is that money will not be allocated for a whole project, but a certain amount will be allocated with a requirement that a report be made before more money is allocated to continue the project, and, in the course of this allocation which, of course, is done by the Comptroller, your Office makes a technical review of the program. It is such that these military agencies have to come up several times, and each time they go through a process of justifying going ahead, and that this has caused the loss of time and great delay.

The other point I wanted to make before I ask you a question is: In the Scientific Advisory Board of the Air Force they recently had an ad hoc committee to study Air Force research and development, and they issued a report in June of 1958. They state that the past decade has seen a growing tendency within the Government and the military to centralize authority, thus removing it from the operating units that still have the responsibility. This philosophy has seriously affected research and development. Then they go on to say—I will not read

everything, but I will put it all in the record at this point so it will be taken in context—the ad hoc committee is convinced that a plan for long weapons development cycle which must be of such serious concern when we compare military progress with that of our potential enemy, that this failure of each echelon and organization to trust lower echelons in other organizations and to discipline itself to do its job well and not to meddle with others, the maze of communications channels, the excess of paperwork, the continual reviews and justification, the diffusion of decisionmaking responsibility, and authority, which are prevalent throughout the Air Force research and development program, constitutes the most formidable single barrier to success and manifestation of this lack of trust and discipline——

Then, they say the trend of the last few years must be reversed, and so on.

I think that Secretary Martin also made a plea for giving more authority and responsibility to the people down the line, and I think Secretary Norton mentioned the fact that he felt that there was too much detailed review at your level.

Now, perhaps there is not and perhaps there is. There is a difference of opinion on it, but I wonder if you would like to comment on these various statements that have been made on this subject?

Dr. FOOTE. Well, I can say this: Most of the ideas that come out of the Air Force are relayed by the Air Force from their contractors because most of the development work of the Air Force is done by contractors like Ramo-Woodridge, and so forth, and so they are simply calling on their contractor.

Now, our contractors make this point, and they are very emphatic about it: They say "You give us the responsibility for doing this, and you need not worry because we will take care of it."

Well, when it comes to policy I think you have to have some higher control because the Army has another group of contractors who say, "Well, you give us the authority and do not question anything we do, and we will give you a satisfactory solution."

It is absolutely essential that we bring all of these competing outside agencies together and discuss their relative merits, and that is what they are objecting to in these reports. They do not like that. It does take time to do that.

You have to go through operational research and highly technical conferences, and probably they do not like it, but I think it is essential for the Government to centralize that type of policy, not to centralize how a thing shall be done, but to centralize what shall be done.

Mr. LANIGAN. Do you think that there are improvements that could be made in your techniques for handling this review? Could you, for example, delegate more authority or responsibility to some of your trusted subordinates and have them work in teams or task forces with the representatives of the military services?

Dr. FOOTE. That is done all the time, every day. For instance, in the electronics field I have two of the outstanding people of the country, Dr. Skifter, and Mr. Bridges—and those fellows are working very closely with all the electronics people of the services, and industry as well.

Mr. LANIGAN. Do they make decisions without reporting back to you? Can they make a decision binding your office without consulting you?

Dr. FOOTE. I think, joining in with the services, they make recommendations, but when the final decisions would be made, they would come up to me.

Mr. LANIGAN. We have one letter of June 28, 1957, in which the Secretary of Defense put out a memorandum issued to the Army, Navy, and Air Force directing that no research and development contract could be executed without prior approval of the Secretary of Defense, and according to our best information that order is still in effect.

Is that correct? Does the Secretary of Defense have to give prior approval to individual research and development contracts?

Dr. FOOTE. No, sir. I do not know about this order. What is it?

Mr. LANIGAN. Can you explain that memorandum, Mr. Huff, and its effects?

Mr. HUFF. That memorandum, again, was issued at the time we were faced with the expenditure limitation because of the debt ceiling and what it really meant was before you make any major expenditure in this area, clear this with the Secretary of Defense. Of course, Dr. Foote was not here at that time, but any research and development contract of any magnitude would have had to have been run through Dr. Foote's office, and his advice to the Secretary of Defense with respect to whether he should approve or not approve it. As a matter of fact, there were a number of projects that were approved, and even we may have had instances where funds were allocated to some of these projects. I do not know of any other effects.

Most of those memoranda that you speak of there, including the August 17 one, have all gone by the boards. You know the August 17 memorandum was rescinded shortly after Mr. McElroy came into office because there was a good deal of confusion about what that memorandum meant, and there has been a lot of misinformation about it in the press and elsewhere.

Actually, the effect of that thing never had a chance to go into being. Some of the things you referred to there I am not aware of, and I do not think anyone in OSD is aware of in terms of the effect of the August 17 memorandum. I am getting a little bit away from the June memorandum.

Mr. LANIGAN. The August 17 memorandum had the effect of causing the Air Force to cancel 254 aircraft contracts, although 79 were restored.

Mr. HUFF. This is not true. The August 17 letter did not have that effect. The reason for those cancellations in the Air Force was because of a 5 percent across-the-board reduction in expenditure levels that they imposed themselves before the August 17 memorandum came out.

In other words, they found it a little difficult to reduce a research contract where 2 scientists were involved on a team by 5 percent. So, the net result of that was a lot of basic research contracts were canceled by the Air Force. This was not true in the Army and Navy. There were a few cancellations in the Army but the August 17 letter did not cause those cancellations. This took place prior to the August 17 memorandum.

Mr. LANIGAN. The cancellations all took place in September.

Mr. HUFF. No; they were——

Mr. LANIGAN. Oh, yes.

Mr. HUFF. They were not renewed long before that. Dr. Foote had a call from Dr. Terman at Stanford—and this was in August—and he was wondering when he would get the information as to whether or not his contract was going to be renewed, and we told him we would try to get some money restored in the Office of Scientific Research in the Air Force to see to it that those very important ones were continued. Of course, we could only go so far because of the expenditure ceiling.

Of course, Dr. Foote helped to get the basic research effort restored, but the August 17 memorandum is not the memorandum that caused the Air Force to cancel those contracts and the record ought to be very clear on that.

I am not the authority on this, of course, but you can find that out with a little research with Mr. McNeil's office, and others.

Mr. LANIGAN. Mr. Chairman, I think we should put in the record at this point a list of Air Force contracts that were canceled and the dates of termination.

Chairman DAWSON. Very well.

(The list referred to follows:)

Air Force contracts terminated as a result of expenditure limitation

Contract No.	*Terminated*
AF18(600)-1457	Sept. 27, 1957.
AF18(600)-1513	Sept. 26, 1957.[1]
AF18(600)-1559	Do.[1]
AF18(600)-1655	Do.[1]
AF18(600)-1669	Do.[1]
AF18(600)-1747	Sept. 27, 1957.
AF18(600)-1749	Sept. 26, 1957.[1]
AF29(601)-549	Sept. 27, 1957.
AF29(601)-547	Do.[1]
AF29(601)-545	Do.[1]
AF29(601)-492	Do.
AF08(616)-59	Do.
AF33(616)-3419	Do.
AF33(616)-2394	Do.
DO-AF(20-601)-57-2890.	Sept. 26, 1957.[1]
AF04(611)-1565	Sept. 27, 1957.
AF19(604)-2225	Do.
AF19(604)-1855	Do.
AF19(604)-1521	Do.
AF19(604)-1862	Do.
AF19(604)-1861	Do.
AF19(604)-1937	Do.
AF19(604)-2149	Do.
AF19(604)-2414	Do.
AF33(616)-3396	Sept. 26, 1957.[1]
AF08(616)-90	Sept. 27, 1957.
AF08(616)-36 Task 1	Do.
AF08(616)-36 Task 2	Do.
AF08(616)-36 Task 3	Do.
AF08(616)-36 Task 4	Do.
AF08(616)-36 Task 5	Do.
AF08(616)-36 Task 6	Do.
AF08(616)-36 Task 7	Do.
AF08(616)-45	Do.
AF08(616)-91	Do.
AF08(616)-106	Do.
AF08(616)-121	Do.
AF08(616)-72	Do.

Contract No.	*Terminated*
AF33(616)-2617	Sept. 27, 1957.
AF08(616)-51	Do.
AF08(616)-117	Do.
AF08(616)-70	Do.
AF08(616)-48	Do.
AF08(616)-29	Do.
AF08(616)-38	Do.
AF33(616)-2394	Do.[1]
AF33(600)-35781	Do.
AF33(616)-3407	Do.
AF33(600)-24419	Do.
AF33(600)-34837	Do.[1]
AF33(600)-21048	Do.
AF33(600)-30725	Do.
AF33(600)-32579	October 1957.[1]
AF33(616)-5370	Sept. 27, 1957.
AF33(600)-26740	September 1957.[1]
AF33(600)-29923	Sept. 27, 1957.
AF33(600)-30250	Do.
AF33(616)-3755	October 1957.[1]
AF33(600)-22566	Sept. 27, 1957.
AF33(616)-5290	Do.
AF33(616)-3240	Do.
AF33(616)-3313	Do.
AF33(616)-3397	Do.
AF33(616)-3417	Do.
AF33(616)-3606	Do.
AF33(616)-3654	Do.
AF33(616)-3845	Do.
AF33(616)-3951	Do.
AF33(616)-5074	Do.
AF33(616)-5161	Do.
AF33(616)-5169	Do.
AF33(616)-2799	Do.
AF33(616)-3219	Do.
AF33(616)-3750	Do.
AF33(600)-29273	Do.
AF33(616)-3450	Do.
AF33(616)-3451	Do.

[1] Reinstated subsequently.

Air Force contracts terminated as a result of expenditure limitation—Continued

Contract No.	*Terminated*
AF33(616)-3600	October 1957.[1]
AF33(616)-5194	Sept. 27, 1957.
AF33(616)-5236	Do.
AF33(616)-5355	Do.
AF33(600)-32535	Do.
AF33(616)-5234	October 1957.[1]
AF33(600)-33902	Sept. 27, 1957.
AF33(600)-29906	Do.
AF33(616)-5241	Do.
AF33(600)-27847	Do.
AF33(038)-14295	Do.
AF33(616)-3128	Do.
AF33(616)-3618	Do.
AF33(616)-3858	Do.
AF33(616)-5148	October 1957.[1]
AF33(616)-5049	Sept. 27, 1957.
AF33(616)-5314	Do.
AF33(616)-5100	Do.
AF33(616)-2000	Do.
AF33(616)-3765	Do.
AF33(616)-3518	Do.
AF33(616)-5302	Do.
AF33(616)-5305	Do.
AF33(616)-5256	Do.
AF33(600)-34962	Do.
AF33(616)-5179	Do.
AF33(616)-5205	Do.
AF33(616)-5126	Do.
AF33(616)-5147	Do.
AF33(616)-2709	October 1957.[1]
AF33(616)-3843	Sept. 27, 1957.
AF33(616)-5207	Do.
AF33(616)-3523	Do.
AF33(600)-31158	Do.
AF33(600)-32641	Do.
AF33(600)-35058	Do.
AF33(600)-35576	Do
AF33(616)-3527	Do.
AF33(600)-21699	Do.
AF33(600)-5104	Do.
AF33(600)-27739	Do.
AF33(616)-5652	Do.
AF33(616)-5281	October 1957.[1]
AF33(616)-3931	Sept. 27, 1957.
AF33(616)-3424	Do.
AF33(616)-2237	Do.
AF33(600)-26993	Do.
AF33(600)-29284	Do.
AF33(616)-3323	October 1957.[1]
AF33(616)-5048	Sept. 27, 1957.
AF33(616)-3914	October 1957.[1]
AF33(616)-3991	Sept. 27, 1957.
AF33(600)-21703	Do.
AF33(616)-2564	Do.
AF33(616)-2841	Do.
AF33(616)-2842	Do.
AF33(616)-3662	Do.
AF33(616)-5238	Do.
AF33(616)-5270	October 1957.[1]
AF33(600)-32630	Sept. 27, 1957.
AF33(616)-3339	Do.
AF33(616)-3246	Do.
AF33(616)-3333	October 1957.[1]
AF33(616)-3443	Sept. 27, 1957.
AF33(616)-3481	Do.
AF33(616)-3521	October 1957.[1]
AF33(616)-3862	Sept. 27, 1957.
AF33(616)-5021	October 1957.[1]
AF33(616)-3611	Do.
AF33(600)-22909	September 1957.
AF33(600)-32331	Sept. 27, 1957.
AF33(600)-34518	Do.
AF33(616)-3039	Do.
AF33(600)-32313	Do.
AF33(600)-29429	Do.
AF33(600)-28110	Do.
AF33(616)-3296	Do.
AF33(616)-5121	Do.
AF33(616)-5246	October 1957.[1]
AF33(616)-3934	Sept. 27, 1957.
AF33(600)-2839	Do.
AF33(600)-34937	Do.
AF33(600)-32427	Do.
AF33(616)-2951	Do.
AF33(616)-3970	Do.
AF33(616)-3351	Do.
AF33(600)-29246	Do.
AF33(616)-5326	Do.
AF33(616)-2936	October 1957.[1]
AF18(600)-1670	Sept. 27, 1957.
AF30(602)-1646	Do.
AF30(602)-1546	Do.
AF30(602)-1729	Do.[1]
AF30(602)-1670	Do.[1]
AF30(602)-1654	Do.[1]
AF30(602)-1700	Do.[1]
AF30(602)-1675	Do.[1]
AF30(635)-2897	Sept. 27, 1957.
AF30(602)-1697	Do.
AF30(635)-4490	Do.
AF30(602)-1552	Do.
AF30(602)-1683	Sept. 26, 1957.[1]
AF30(602)-1662	Sept. 27, 1957.
AF30(602)-1481	Do.
AF30(602)-1621	Do.
AF30(602)-1782	Sept. 26, 1957.[1]
AF30(602)-1676	Sept. 27, 1957.
AF30(602)-1684	Do.
AF30(602)-1761	Sept. 26, 1957.[1]
AF30(635)-2908	Sept. 27, 1957.
AF30(602)-1562	Do.
AF30(635)-4495	Do.
AF30(602)-1657	Do.
AF30(602)-1660	Do.
AF30(602)-296	Sept. 26, 1957.[1]
AF30(602)-1539	Sept. 27, 1957.
AF30(602)-1559	Do.
AF30(602)-1720	Do.
AF30(602)-1766	Do.
AF33(616)-3483	Do.
AF30(602)-1644	Do.
AF30(602)-1445	Do.
AF30(602)-1502	Do.
AF30(602)-1768	Sept. 26, 1957.

[1] Reinstated subsequently.

Air Force contracts terminated as a result of expenditure limitation—Continued

Contract No.	Terminated
AF30(602)-1633	Sept. 27, 1957.[1]
AF30(602)-1672	Sept. 26, 1957.[1]
AF30(602)-1740	Do.[1]
AF30(602)-1635	Do.[1]
AF30(602)-1716	Do.[1]
AF30(602)-1767	Sept. 27, 1957.
AF30(602)-1776	Sept. 26, 1957.[1]
AF30(602)-1584	Do.[1]
AF30(602)-1772	Do.[1]
AF30(602)-1648	Do.[1]
AF30(602)-1666	Sept. 27, 1957.
AF30(602)-1710	Sept. 26, 1957.[1]
AF30(602)-1705	Do.[1]
AF30(602)-1763	Do.[1]
AF30(602)-1760	Do.[1]
AF30(602)-1636	Sept. 27, 1957.
AF30(602)-1699	Sept. 26, 1957.[1]
AF30(602)-1616	Do.[1]
AF30(602)-1605	Do.[1]
AF30(602)-1769	Do.[1]
AF30(602)-1619	Do.[1]
AF30(602)-1765	Do.[1]
AF30(602)-1747	Do.[1]
AF30(602)-1435	Sept. 27, 1957.
AF30(602)-1523	Oct. 10, 1957.[1]
AF30(635)-4493	Sept. 27, 1957.
AF30(602)-1734	Do.
AF30(602)-1523	Oct. 10, 1957.[1]
AF30(602)-1656	Oct. 18, 1957.[1]
AF19(604)-1189	Sept. 27, 1957.
AF30(602)-01531	Oct. 10, 1957.[1]
AF30(602)-1597	Sept. 27, 1957.
AF30(602)-1643	Do.
AF30(602)-1764	Oct. 9, 1957.[1]
AF30(602)-1665	Oct. 21, 1957.[1]
AF30(602)-1713	Sept. 27, 1957.
56-1415	Do.
56-1451	Do.
57-1653	Do.
AF30(602)-1734	Do.
AF30(602)-1749	Oct. 17, 1957.[1]
AF30(602)-1774	Do.[1]
AF30(602)-1630	Do.[1]
AF30(602)-1718	Do.[1]
AF30(602)-1781	Oct. 19, 1957.[1]
AF30(602)-1724	Oct. 18, 1957.[1]
AF30(602)-1745	Oct. 17, 1957.[1]
AF30(602)-1752	Do.[1]
AF30(602)-1707	Oct. 22, 1957.[1]
AF30(602)-1725	Oct. 17, 1957.[1]
AF30(602)-1789	Do.[1]
AF30(602)-1693	Sept. 27, 1957.
AF30(602)-1731	Oct. 17, 1957.[1]
AF30(602)-1755	Sept. 27, 1957.
AF30(602)-1780	Oct. 17, 1957.[1]
AF30(602)-1704	Sept. 27, 1957.
AF30(602)-1746	Oct. 18, 1957.[1]
AF30(602)-1762	Oct. 10, 1957.[1]
AF30(602)-1770	Oct. 17, 1957.[1]

[1] Reinstated subsequently.

Chairman DAWSON. Gentlemen, we are drawing to a close.

Dr. Foote, I see you have a written memorandum on each one of the points involved here. Would you file those answers, and we will go over them?

Dr. FOOTE. These are rough notes, and I will polish them up and get them to you in a day or so.

Chairman DAWSON. Thank you.

(The matter referred to follows:)

I. Effect of (a) year-to-year changes in moneys appropriated, (b) rising costs, (c) increased complexity of weapons, and (d) expenditure limitations on the ability of the military services to carry on research and development programs which they believe the Nation's security requires

(*a*) *Effect of year-to-year changes in moneys appropriated.*—It is generally agreed that a fairly level, steady program in research and development provides a greater payoff than a program with sharp ups and downs or one with a high "crash" program content. We must maintain a constant military research and development program by exploring all research frontiers and insure a steady flow of superior weapons. To accomplish this also means a steady flow of funds without sharp peaks and valleys. I believe we have maintained a steady flow of funds for this important work. To illustrate this point I have a table I would

like to quote from which shows both new obligational authority and expenditures from research and development appropriations for the fiscal years 1947–59.

[Millions of dollars]

Fiscal year	NOA	Expenditures	Fiscal year	NOA	Expenditures
1947	545	515	1954	1,389	1,385
1948	475	534	1955	1,305	1,391
1949	629	608	1956	1,420	1,491
1950	588	539	1957	1,710	1,686
1951	1,176	758	1958	1,875	1,838
1952	1,455	1,164	1959	2,733	[1] 2,325
1953	1,586	1,412			

[1] Estimated.

(*b*) *Effect of rising costs.*—There is no question that rising costs have affected the research and development effort, but this has been at least partially offset by greater selectivity in the development of items, improved management by wider use of experienced research-management teams, and by the increasing support of funds from the procurement- and production-type accounts, which, with the research and development appropriations, are an integral part of the larger "research, development, test, and evaluation" program.

Your committee staff has been provided with copies of a study conducted in my office which adjusts the availability of research and development funds by applying a research and development index. This study points out that it now takes $1.60 to buy $1 worth of 1950 research and development. This, of course, does not take into consideration the increasing support of procurement and production-type funds, which amounted to $1.8 billion in fiscal year 1955 and climbed to $3.3 billion in fiscal year 1958.

If we consider the broad scope of the research, development, test, and evaluation programs of the Department of Defense, we find a steady and marked increase since fiscal year 1955. This is clearly revealed by the following table covering actual and projected obligations for these purposes.

[Millions of dollars]

Fiscal year	Research and development appropriations	Activities supporting research and development	Development, test, and evaluation items	Total
1955	1,350	344	1,826	3,520
1956	1,539	446	1,830	3,815
1957	1,651	633	2,804	5,088
1958	1,887	425	3,921	5,602
1959 (President's Budget)	2,588	444	3,187	6,219

Between fiscal years 1955 and 1958, there was an increase of $2,082 million, or over 59 percent, in the funds applied to the Department of Defense research, development, test, and evaluation programs. During this same period, the research and development index, mentioned earlier, increased by 15.4 percent. Thus, even if the $5.6 billion devoted to research, development, test, and evaluation in fiscal year 1958 is deflated by the amount of the increase in the research and development increase; there is an increase in real terms of $1½ billion—or 38 percent—over the 1955 level. Furthermore, the President's budget for fiscal year 1959 provides for an additional increase of $600 million—or 11 percent over the 1958 level.

(c) *Effect of increased complexity of weapons.*—It is recognized that the complexity of modern weapons systems and the growth of these developments to the expensive stages of test, evaluation, and procurement have created a vast drain on money and talent. The complexity factor, along with the rising cost factor, is always given special consideration when developing research and development budgets.

Some examples of the effect of both the rising cost and complexity factors are as follows:

The B–29 in World War II cost $600,000; a B–36, $4 million; and the present B–52 nearly $8 million. It is estimated that the B–70 when operational will cost several times as much as the B–52.

A World War II fighter aircraft, the F–47, cost $92,000; the present F–100, $750,000; and the F–105 will cost about $4 million. Development costs alone for one X–15 aircraft may reach $100 million.

Submarines cost less than $5 million in World War II; $22 million in the Korean war. The *Nautilus* type costs almost $50 million, while the *Polaris*-type submarine, now under development, is estimated to cost about $100 million.

We must not overlook the fact that along with the rising costs and the increasing complexity of our weapons, we have obtained substantial gains in the effectiveness of our weapons.

(d) *Effect of expenditure limitations on the ability of the military services to carry on research and development programs which they believe the Nation's security requires.*—Research and development along with every other program, of course, felt the effect of the expenditure limitations imposed in fiscal year 1958, but under the debt ceiling and other conditions that existed during that period, including the climate of public opinion which was reflected in congressional demands for reductions in Government expenditures, Department of Defense expenditures had to be reduced. In adjusting Department of Defense programs toward the prescribed levels, all programs had to be critically reexamined and reevaluated. Research and development programs were not exempted from these efforts, but, on the whole, were subjected to less revision than any other significant Department of Defense activity.

It is believed that the long-term effect of the fiscal year 1958 expenditure limitations will be relatively minor. Moreover, despite the expenditure limitations a very substantial and worthwhile research and engineering effort was carried out in fiscal year 1958.

II. Problems of budgeting and accounting which adversely affect research and development operations

There are no budget and accounting problems that are significantly affecting our research and development operations at the present time.

There were a number of problems following World War II and following the Unification Act of 1947. Most of these problems have been eliminated and a number of real improvements have been made in this area. For example: Prior to fiscal year 1950 there was not a single research and development appropriation in any 1 of the 3 military departments. Today the Army, Navy, and Air Force all have single research and development appropriations, all of which are no-year appropriations.

Prior to fiscal year 1951 there was no provision at the Secretary of Defense level for funding departmental emergency research and development needs. In other words, we had no effective way to meet critical new requirements, take advantage of technical breakthroughs, or to take care of newly found operational deficiencies.

The Congress recognized this need and gave the Secretary of Defense an emergency fund for this purpose. Thus, from fiscal year 1951 through 1958 roughly $712 million has been allocated to the military departments from this fund in addition to the regular research and development appropriations.

In January 1955 we established for each military department a uniform appropriation structure within the single research and development appropriations and a uniform classification system for reporting obligations and expenditures under nine major classifications.

At the request of Congress, over the fiscal years 1955 and 1957 we transferred from other type appropriations certain other costs elements properly chargeable to the research and development appropriations.

Until a few years ago there was no mechanism available to identify the procurement and production type funds by item which supported the broader research, development, test, and evaluation program. Today we have a coding

system of all procurement and production type funds which identifies each item as Code A or Code B. Code A are line items of materiel which have been approved for service use. Code B are line items of materiel which have not been approved for service use, and they are identified as development and test or nonstandard items subject to review of this office.

Some of the testimony before this committee may have given the impression that the research and development program has been hampered in some fashion by the Department of Defense financial plan. It can be stated categorically that the financial plan does not in any way reduce the availability of research and development funds carried over from one year to next. Actually, the financial plan is simply a means to lay out for consideration by both the executive branch and the Congress all the financial resources available to the Department of Defense and the planned application of those resources. It is significant that the financial plan has been highly praised by the congressional Appropriations Committees as an invaluable aid for consideration of the financial aspects of the Department of Defense programs.

Although there has been discussion during the hearings of both the Department of Defense financial plan and of various aspects of apportionment procedures, there has been no clear presentation of the interrelationship of these financial elements to various program elements in the Department of Defense. I believe it would help clarify the record to insert at this point a copy of a recent statement made to a special subcommittee of the House Armed Services Committee by the Assistant Secretary of Defense (Comptroller), which covers this matter in some detail (attachment A).

In summary, real progress has been made in the improvement of budget and accounting policies and procedures and further progress may be expected.

III. Fiscal, organizational, and operational problems arising from the centralization of control and detailed direction of research and development, including those arising in the relationships between the military services and the Office of the Secretary of Defense

Any fiscal, organization, operational, or relationship problems that we face from time to time do not arise because of the "centralization of control and detailed direction of research and development." For example, the major fiscal problem that we have is to make sure that the vast sums of money appropriated are used wisely. Also, even though we are requesting the huge sum of $6.2 billion for our research and engineering programs for fiscal year 1959, this sum will not take care of all of the work proposed for research and development. Therefore, selectivity of the highest order must be practiced.

With respect to organizational problems, any difficulties that we have stem largely from the sheer size and complexity of the Department of Defense research and engineering effort.

With respect to relationships with the military departments, I know of no serious problems that have arisen. However, there are times when honest differences of opinions arise with respect to certain projects or programs. These differences of opinions are natural to expect and there is no way they can be entirely eliminated, nor should they be eliminated. It is only through full discussion of controversial programs where huge sums of money are involved and where the security of the Nation is involved that we can arrive at sound decisions.

The job assigned to the ASD (R. and E.) is, first, to provide the broad policy direction and guidance to the military departments and joint agencies under which they develop the detailed policies and plans for the execution of their individual programs. Second, to conduct a continuous review of the DOD research and engineering programs. Obviously, the Secretary of Defense must have some organization to advise and assist him in the highly important area of research and engineering since he could not give it adequate attention in view of his many other responsibilities.

Sometimes, as a result of our review of departmental programs, a delay, or what is called delay occurs. I know of no case where any so-called delay has resulted in lack of progress. More frequently, any delay caused by our review has resulted in a better final solution or decision.

Certainly, the Office of the Assistant Secretary of Defense (Research and Engineering) does not exercise "detailed direction of research and development." Rather, we try to give the best guidance we can, and apply the best judgment we can, particularly to the major programs.

IV. Problems arising from the policy of a fixed dollar level for research and development in a time of rising prices and increased weapons complexity

There has never been a policy of a "fixed dollar level for research and development in a time of rising prices and increased weapons complexity." Rather, there has been an increasing recognition of the importance of research and engineering as reflected by the increased sums made available in recent years.

Here again, the big problem is to make certain that we use the huge sums that are available for research and engineering as effectively as possible. The $6.2 billion that we will have available for research and engineering in fiscal year 1959 is nearly one-sixth of the total DOD budget for 1959. This I consider to be a fair share for research and engineering activities. This, of course, will not provide money for all the things that we associated with research and engineering would like to do. There will never be enough money on that basis. We have to recognize that there are other important programs and that it would not be in the national interest to devote a disproportionate part of our resources to the development of new items at the expense of being able to equip and maintain the necessary forces in being.

V. Utilization of results of basic research in weapons development

The results of basic research constitute the only actual source of so-called unconventional items of military utility. Such items are often responsible for tremendous and relatively sudden increases in military capabilities, as contrasted with the percentage improvements frequently sought by engineering refinements of known principles.

Examples of the utilization of basic results are plentiful—a classic case being the development of nuclear weapons after the laboratory discovery of the fission of uranium. Work in fundamental physics of solids led to the invention of transistors, which have made possible the miniaturization of electronic equipment. Experiments with compounds in which carbon atoms are replaced silicon atoms have yielded silicones which range in utility from low-temperature lubricants to high-temperature varnishes. Routine navigational methods depend upon the results of centuries of astronomical observations, while radio telescopes show promise of utility in modern guidance systems. Adequate ICBM guidance requires of geophysics a better knowledge of the shape and size of the earth and the properties of its atmosphere. High temperature research in materials laid the groundwork for the design of rocket motor nozzles and nuclear reactor components; while only a short time ago the area of magnetohydrodynamics, so vital now in investigations of controlled thermonuclear reactions, was of appreciable interest only to astrophysists. Gigantic computers have grown from pure mathematical concepts, and operations analysis has evolved from game theory. A highly digestible, entirely synthetic concentrated liquid diet, designated during recent years to sustain the complete life cycle of experimental animals for use in cancer research, now promises to be directly applicable to nutrition problems in space travel.

It is not surprising to note that most of the above basic research results did not come from the DOD research program. That program has been in existence for only about 10 years, and revolutionary ideas are rare. However, with adequate support and a favorable intellectual climate, there is no reason why a proportionate number of results of major significance should not be produced.

The elapsed time between the accomplishment of a basic research result and its application is decreasing at a tremendous rate. Half a century ago, a lag of decades was not unusual. Six years after the discovery of fission, a nuclear weapon was exploded. The transistor and the MASER (microwave amplification by stimulated electromagnetic radiation) were usable about 3 years after their discovery. As this time decreases, it is essential that the reservoir of fundamental knowledge be replenished. Basic research does provide raw material for development, but by and large development does not stimulate the production of important fundamental ideas to any similar extent.

VI. Problems involved in retaining competent personnel

The 24th Intermediate Report of the Committee on Government Operations in August 1954 called attention to several administrative problems adversely affecting the recruitment and retention of competent research and development personnel. Progress has been made in a number of these areas. The recent Pay Act raising Federal salaries 10 percent also authorized the Civil Service Commission to recruit college graduates at the GS–7 level in occupational groups

in short supply, and established 157 additional Public Law 1028 positions in the Department of Defense. These measures, coupled with the earlier Commission action placing the salaries of most physical scientists and engineers at the top of the grade, have helped improve the recruitment and retention situation. We must recognize, however, that these are short-term measures. The study of the Federal pay structure currently underway in the executive branch should result in basic long-range improvements in the Government's ability to compete for competent personnel, in flexibility to recognize individual differences in ability and performances, and in a better alinement of scientific and engineering positions by occupations. The addition of 157 Public Law 1028 positions brings the number of such positions available to the Department of Defense to 292, far short of the Department's urgent proposal for 450 scientific and professional positions in this category.

Although pay is one of the most important factors in retaining competent personnel, the Department has also taken action to improve other conditions affecting retention. Career development, utilization, and incentive awards programs for civilian and military personnel have been actively promoted. Attendance at scientific and professional meetings has been facilitated and encouraged. The military departments have given particular attention to the results of an attitude survey conducted under the auspices of the Committee on Scientists and Engineering for Federal Government Programs to effect substantial improvements in better utilization of scientific skills and in the working environment.

Both in the military departments and in the Office of the Secretary of Defense, there is a very real awareness of the importance and scope of the problems facing us in this area. We need an ample supply of high-caliber scientists, mathematicians, and engineers. We need quality, and we need it in considerable quantity.

VII. Areas in research and development where efforts should be concentrated to minimize serious waste of funds through duplication, unwise development, and other causes

The elimination of unwarranted or unnecessary duplication and unwise development, of course, is one of the principal responsibilities assigned to my Office. At the same time, it is also my responsibility to expedite sound programs and to encourage efforts where we find serious gaps.

For example, I would like to discuss the important area of basic and supporting research. Since taking office, one of the most pressing problems that I have faced is to determine the amount of basic and supporting research required to assure that each succeeding generation of military weaponry is improved to the greatest extent possible.

We have taken several actions to meet this objective. First, we issued a policy directive governing the provision for and the conduct of basic research in the Department of Defense.

Second, in this fiscal year, by use of the transfer authority to the emergency fund we have augmented the basic and supporting research programs in a substantial way; $31.6 million were made available for important and highly critical work in the physical, medical, and geophysical sciences; $10 million were made available for basic work in the field of materials; and $12.5 million were provided for essential work in electron tubes and electronic parts. Thus, we have raised the level of basic and supporting research from around $85 million to around $140 million.

In basic and supporting research, we seek to encourage duplication or parallel approaches to the solution of a problem. Here, we want all the good ideas we can get. Duplication here is highly desirable and relatively inexpensive. However, when we reach the development stage, we must select the best approach and eliminate unnecessary duplication. Here, as we approach the hardware stage, we must make a choice, however difficult, because we simply can't afford to carry into production several types of weapons designed to accomplish the same purpose.

VIII. Nature and results of research and development work performed overseas

European contract offices.—The military departments maintain European offices (Brussels, Frankfurt, and London) to support scientific research, chiefly basic, on a modest level, and to exchange scientific information between the United States and Europe; the work also serves to fill gaps in the United States research program.

As of March 1, 1958, to total level of this research was 87 contracts at a cost of about $4.5 million. Considered expansion of this activity to South and Central America and the Far East has not yet been acted upon.

Mutual weapons development program.—The MWDP, a much larger activity, mobilizes and coordinates European scientific work, speeds the development of new items for European defense production, and assures the resulting technical knowledge for the United States. Current participants are Belgium, France, Norway, the Netherlands, United Kingdom, Federal Republic of Germany. Further extension to friendly countries is being considered.

MWDP projects, screened before United States acceptance and assigned to suitable military departments for monitoring, concern specific military needs, operations research, support of technical centers, and exchange of data in areas of mutual interest.

During MWDP's first 5 years (about 150 projects), the United States and the countries of origin each furnished about $150 million, on about a 50–50 basis.

Many completed items now in production are available to other friendly nations. Examples of completed projects are:

Lightweight tactical strike fighter for NATO
Air Defense Technical Center (at The Hague), which completed a communications system extending the DEW line through Europe to Turkey
Wire-guided SS–10 and SS–11 antitank missiles
Antisubmarine weapons
New aircraft and guided missiles
Electronic devices, lightweight jet engines, rocket propellents, new munition types, etc.

The MWDP also serves as a vehicle for the President's recently announced policy of increased sharing of scientific information with our allies.

IX. Effect of military requirements on scope of research and development

It is assumed that "military requirements" as used here refers to the formal statement which is a part of the development planning procedure of each of the military departments. The military requirement statement sets forth, in rather general terms, the need for a particular weapon and prescribes its desired operational capabilities. The military requirement statement then becomes the guideline for the hardware-development project.

The requirement may set a high objective in that it will require reaching out beyond what is now available. It will strain the state of the art, so to speak. When development work is underway it migh turn out that the formal requirement set too high an objective in one or several of the performance demands placed on the new weapon. At this point the blind pursuit of an idealistic objective may take considerable time. The development administrator must step in and decide that a compromise is needed, that the sights must be lowered to finish the task in a reasonable time.

Thus the situation requires judgment at all points. Certainly we must set forward-looking objectives for our new weapons work, but we must not set them so high as to be unattainable or to require unreasonable or futile and endless development work. Furthermore, in carrying out development work the managers must be ever sensitive to this factor and maintain the flexibility to alter the objectives as various road blocks are reached and evaluated.

X. Lessons to be learned from conduct of industrial and other research

We depend heavily on industry for our research and development; 70 percent of our research and development dollar is spent under contract with industrial laboratories and with universities and nonprofit institutions. Thus, a major portion of our work is actually conducted in industry and the universities. In this manner we take advantage of the scientific and engineering experience of the country as a whole. There are other ways we keep in contact with industrial practices both from the management and the technical viewpoints. Many of our senior civilian officials in charge of research and development have had experience in industrial organizations. There is also some movement of scientists and engineers in our laboratories into and out of industry. Many of our technical officers have been closely associated with research and development as conducted in industry by virtue of their assignments to laboratories and to procurement offices. The capability of these officers is indicated by the responsible positions in industrial management attained by many of them upon retirement from the military service.

We also, at all levels in Defense, utilize civilian scientific and engineering consultants to assist and advise us on our problems. In the Office of the Assistant Secretary (R. & E.), for example, we have available over 360 consultants. They are outstanding scientists and engineers from industry and the universities and we use them constantly.

For these reasons I believe there is no great difference in the way industry conducts research and the way it is done in Defense.

ATTACHMENT A

STATEMENT OF ASSISTANT SECRETARY OF DEFENSE W. J. MCNEIL, BEFORE SPECIAL SUBCOMMITTEE NO. 5 OF THE HOUSE ARMED SERVICES COMMITTEE, MARCH 27, 1958

Mr. Chairman and members of the committee, I welcome the opportunity to appear before this committee to discuss the apportionment process in the Department of Defense. That the apportionment process—its origin, purpose and method of operation—is not fully understood, even in parts of the Defense Department, is evident from some of the testimony presented before the House Armed Services Committee earlier this year. Although this is necessarily a somewhat complicated matter, I believe we can adequately cover the fundamental aspects of the apportionment process without discussing all the technical details involved.

You have heard from the Bureau of the Budget representatives an explanation of the aspects of the law requiring the apportionment of funds appropriated by the Congress and the role of the Bureau in the apportionment process. I would like to direct my remarks to the apportionment process in the Department of Defense, with particular reference to the Office of the Secretary of Defense. But first I would like to touch briefly on those portions of the law which are of particular significance to the apportionment process.

Paragraph (c) (1) of section 3679 of the Revised Statutes, as amended, provides that:

"* * * funds available for obligation for a definite period of time shall be so apportioned as to prevent obligation or expenditure thereof in a manner which would indicate a necessity for deficiency or supplemental appropriations for such period; and all appropriations or funds not limited to a definite period of time, and all authorizations to create obligations by contract in advance of appropriations, shall be so apportioned as to achieve the most effective and economical use thereof."

Paragraph (c) (2) states:

"In apportioning any appropriation, reserves may be established to provide for contingencies, or to effect savings whenever savings are made possible by or through changes in requirements, greater efficiency of operations, or other developments subsequent to the date on which such appropriation was made available. Whenever it is determined by an officer designated in subsection (d) of this section to make apportionments and reapportionments that any amount so reserved will not be required to carry out the purposes of the appropriation concerned, he shall recommend the rescission of such amount in the manner provided in the Budget and Accounting Act, 1921, for estimates of appropriations."

Paragraph (c) (4) provides:

"Apportionments shall be reviewed at least four times each year by the officers designated in subsection (d) of this section to make apportionments and reapportionments, and such reapportionments made or such reserves established, modified, or released as may be necessary to further the effective use of the appropriation concerned * * *."

Paragraph (d) (2) provides that:

"Any appropriation available to an agency, which is required to be apportioned under subsection (c) of this section, shall be apportioned or reapportioned in writing by the Director of the Bureau of the Budget."

Paragraph (d) (2) also establishes the basic responsibilities of the Agency head, namely that:

"The head of each agency to which any such appropriation is available shall submit to the Bureu of the Budget information, in such form and manner and at such time or times as the Director may prescribe, as may be required for the apportionment of such appropriation."

As has been noted, the law provides that while apportionments and reapportionments of funds for the executive branch be made by the Director of the Bureau of the Budget, the head of each agency is required to submit to the Bureau of the Budget information in such form and manner as the Director may prescribe. These requirements for information are set forth by the Bureau of the Budget in its Circular A–34. Under these implementing instructions the Bureau prescribes the apportionment schedules to be used by the agencies and departments in providing the information prescribed by the Bureau of the Budget in meeting the requirements of the law.

The statute provides that apportionment schedules shall be submitted to the Bureau of the Budget not later than 15 days after approval of the appropriation act and that the Bureau of the Budget shall act on the apportionment schedules within 30 days after approval. As a practical matter, the military departments start the preparation of their apportionment requests and supporting data sometime before the appropriations for any given fiscal year are enacted, but usually after the Defense appropriation bill has been passed by the House. These requests are forwarded to the Office of the Secretary of Defense, who as head of the agency, is required to submit the formal request to the Bureau of the Budget. The standard apportionment and reapportionment schedule has been modified for Defense Department use by the Bureau of the Budget in order to show on the same form the amount submitted by the military departments or other components of the Department of Defense, as well as the amount officially requested by the Secretary of Defense.

Prior to transmission to the Bureau of the Budget, each apportionment schedule is reviewed within the Office of the Secretary of Defense. Where an apportionment request covers programs or items in which no significant changes have been made from the time they were presented to, and approved by the Congress, the reviewing process is essentially simple and direct and requires very little time to accomplish. It is important to note, however, that the detailed program data presented to the Congress in support of the appropriation requests are sometimes subject to change as to the individual items to be bought or projects to be undertaken. This is particularly true in the procurement and research and development areas which are so greatly affected by technological progress. Consequently, it is frequently in connection with the apportionment request that some parts of the final "shopping list" for the year are presented for approval for the first time. The apportionment process as it pertains to the military-construction programs entails some special problems which I will discuss separately, a little later.

In these more difficult areas the apportionment review for the Secretary of Defense entails both a fiscal and a program analysis and is undertaken in coordination with the functional or technical staffs within the Office of the Secretary of Defense. For example, an apportionment request for research and development funds would be reviewed by the Office of the Assistant Secretary of Defense (Comptroller) in consultation with the Office of the Assistant Secretary of Defense (Research and Engineering) on the technical or program aspects of the problems involved. Thus, the Secretary of Defense is provided such fiscal and technical advice as he may require to perform properly his role in the apportionment process as "head of the agency."

In making this review each apportionment request is tested against certain criteria. For example, is the apportionment request consistent with the overall Department of Defense financial plan which is presented to the Appropriation Committees of the Congress as an integral part of the defense budget and which is revised as required to reflect congressional action on the budget and subsequent changes in the defense program?

Inasmuch as the financial resources available to the military departments include not only appropriations for the fiscal year but also the amounts carried over from previous fiscal years, as well as reimbursements for materiel and services furnished to others (particularly the military-assistance program), some mechanism must be employed to pull all these resources together in one place and relate them to their planned use. This is the purpose of the overall Department of Defense financial plan which covers all general and special Department of Defense appropriations.

Briefly, this financial plan shows the unobligated funds brought forward into the fiscal year, the appropriations enacted for the year, transfers from one account to another as authorized by the Congress, the reimbursements expected to be received during the year for goods and services furnished to others, and the estimated recoveries of prior-year obligations. These, in the

aggregate, constitute the total resources available to the Department of Defense for obligation and commitment. The remainder of the financial plan shows the planned application of these resources—the amounts planned for apportionment during the year, both for obligation and commitment, and the amounts projected to remain unobligated at the end of the fiscal year which, except for unusual situations, represent amounts earmarked to complete programs or projects underway.

I would like to take a few moments to discuss these unobligated balances in a little more detail. The Congress—largley at the insistence of the House—has for some years followed the general rule of appropriating for the full cost of a given program in the year in which it is approved, even though it is recognized that some portion of the funds might not be obligated or even committed until later years. This procedure has the advantage of disclosing the full cost of a program at the time it is first presented for appropriation. It does, however, require the Department of Defense to hold in reserve for use in later years those funds needed to complete programs authorized or started in the current year. These funds are specifically identified in the financial plan as reserved for carryover into the succeeding fiscal year.

In addition to the amounts reserved for completion of programs authorized by the Congress, it must be recognized that some of the funds apportioned for use during the year will necessarily remain unobligated—even though legally committed—at the end of the fiscal year. By this we mean that firm procurement or construction directives will have been issued and contracts and spare parts provisioning will be in various stages of negotiation, but the transactions involved will not yet have progressed to the point where they meet the statutory definition of obligations pursuant to the specific criteria established by section 1311 of Public Law 663, 83d Congress. In order to avoid disrupting the efficient and orderly flow of business, funds must be made available in the apportionments to cover these commitments.

The current financial plan for fiscal year 1958—with $36.6 billion appropriated by the Congress—contemplates gross obligations of $43.6 billion although the amount expected to be apportioned would be almost $48.6 billion. Of this amount, about $48 billion has already been apportioned to date, leaving about $600 million—less than 1½ percent—to be apportioned during the remainder of the fiscal year. This 1½ percent represents programs or projects which in whole or in part have not yet been firmed up.

In reviewing an apportionment request it must also be determined whether the funds requested are to be used for the purposes for which appropriated, or, more specifically, for the programs presented to the Congress in justification of the appropriation request. Where changes in programs have been made, it must also be determined whether the apportionment request is consistent with the latest approved programs.

The defense program by its very nature is highly subject to change—not only as the result of the extremely rapid technological progress now being experienced—but also as the result of shifts in the international situation. This has been well illustrated by the events of the last several months.

Furthermore, because of the rapid progress in science and technology, defense programs, particularly in research and development, must sometimes be projected beyond what would normally be prudent. Some of these programs simply do not develop as fast as had been anticipated when the budget was prepared, and are not ready to go forward when the appropriations are made. Others may develop more rapidly than anticipated and could profitably use more funds than may have originally been planned for them.

For these and similar reasons, the program backup for each apportionment request must be reviewed to assure that the latest program decisions are reflected therein. This process is complicated by the fact that program changes in one area, such as military personnel, will affect programs in many other areas—clothing, food, travel, military construction, maintenance and operation, etc. All of these program changes must be taken into account in order to assure that the defense program as a whole can move forward in a balanced manner. This particular aspect of the problem is specifically recognized in section 3679 of the Revised Statutes which requires that such changes be taken into account in the apportionment process.

I might note at this point that when major program changes occur subsequent to the date on which appropriations become available, apportionments are processed as soon as the necessary reprograming is completed. Barring some excep-

tional circumstances, such program changes are the principal factor causing delay in the release of funds.

Another requirement which must be checked is whether the programs to be funded by a particular apportionment request duplicate, in whole or in part, programs to be funded in other apportionment requests. Because of the close interrelationship among the programs of the 3 military departments, the possibility always exists that 1 department will plan to undertake work which another department also plans to undertake. Resolution of these problems is often very difficult, inasmuch as some degree of duplication may be desirable in the particular instance. It is particularly difficult to resolve these problems quickly when they involve questions of service missions. In these cases apportionment requests are processed as soon as the problems are resolved.

Another question which must be resolved in the apportionment review is whether the rate of obligation proposed is consistent with the expenditure estimates incorporated in the budget submitted to the Congress. The Department of Defense has always considered the expenditure estimates presented to the Congress in the annual budget as an essential element in its overall financial plan. Because of its sheer size, the defense program has a most important impact on the total Federal budget and the financing plans of the Treasury. For this reason, it has been necessary for the Defense Department to make every effort to conduct its programs in such a way as to live up to its commitments to the executive branch and the Congress.

When it is found that for various reasons expenditures are running significantly above the estimates, the Department is required to make the necessary program adjustments. Naturally, these adjustments are made in a manner best calculated to protect the essential elements of the defense program, but some adjustments in projects already underway and in those planned to be started may be necessary. This, in turn, may require adjustments in the approved apportionment.

The apportionment review must also take account of changes in prices or costs which may have occurred subsequent to the presentation of the defense programs to the Congress. It must also take account of any specific requirements or limitations imposed by the Congress.

While the apportionment procedures and concepts that have been outlined are applicable to all appropriations, it should be noted that the programs financed from military construction appropriations are subject to modified apportionment procedures that have been tailored to meet their specific needs. Before discussing the currently applicable procedures, I believe it would be useful to discuss briefly the circumstances which generated them.

I am sure you all remember the Moroccan airbase construction situation and the extensive hearings, investigations, and reports by congressional committees of both Houses. In the investigation conducted by the Defense Subcommittee of the House Committee on Appropriations, great difficulty was encountered in determining the amounts of funds which were apportioned, allocated, and obligated for this construction. Granted, there were circumstances resulting from the outbreak of hostilities in Korea which contributed to this problem. Nevertheless, under the normal apportionment procedures in effect at the time, there was no document which indicated the funds apportioned for this construction program. For such reasons, the committee was critical of the Department of Defense and the Bureau of the Budget.

A study of the apportionment procedures then in effect was instituted and a system was developed to establish certain control points which identified apportionments, allocations, and obligations. As a result of this study, procedures were issued by the Director of the Bureau of the Budget on November 6, 1952, effective with the commencement of fiscal year 1953. Under these procedures, funds were apportioned and identified for specific locations, and obligational limitations were established for each one of those locations, in addition to the total obligational limitation for the appropriation shown on the apportionment form. Adjustments or changes in the amounts for each location were subject to apportionment actions. In other words, savings in the approved program at one installation could not be utilized to cover overruns in the approved program at other installations without going through the normal apportionment channels to receive the Bureau of the Budget's approval. The uncertainties of that period, together with lack of proper advance planning and a definitive program, warranted such limitations.

As late as fiscal year 1954, when no construction appropriations were requested for the Army and the Navy and with a very limited amount requested for the Air Force, it was felt that the apportionment procedures then in effect served a very useful purpose, particularly since the Army and Navy were unable to present a specific program for the use of the available funds consistent with the authorization then available. The procedures facilitated the application of available funds to finance the new authority granted by the Congress and to mesh the old programs with new programs by defunding all items at specific locations no longer required and applying the funds to new requirements at other locations.

While justified by the circumstances which led to their application, these apportionment procedures were extremely limiting and did not provide the necessary flexibility for orderly program management. This was especially true in the light of the more stable situation achieved in recent years and improved advance planning of construction programs. Consequently, in July 1956, we proposed revisions to the Bureau of the Budget which would eliminate station-by-station control of military construction funds and substitute a program type of control. In February 1957, the Budget Director rescinded some of the more restrictive procedures established in 1952 and authorized apportionment procedures generally in accordance with our recommendations of July 1956. The Budget Director also requested the development, in conjunction with the Bureau of the Budget, of an appropriate system for reporting the status of the construction program.

Since more than 7 months of fiscal year 1957 had already elapsed, it was decided to put the revised apportionment procedures into effect at the beginning of fiscal year 1958, and this was done by a Department of Defense directive issued by the Secretary of Defense on May 29, 1957. The intent of the revised procedures was clearly outlined in the following paragraphs:

"A. It is desired that the apportionment procedures delegate maximum responsibility to the military departments and at the same time maintain such controls as are necessary to properly discharge the duties and responsibilities of the Secretary of Defense. It is incumbent upon this office and the military departments that all measures be taken to insure that the construction program will secure, to the maximum extent possible, those items which were justified to the Congress and which remain essential to the accomplishment of assigned missions.

"B. Under the revised apportionment procedures attached hereto, it is contemplated that detailed program review of public works projects will be limited generally to areas where adjustments are required by law or other congressional action, where significant changes have occurred in requirements or other pertinent circumstances subsequent to the authorization and appropriation review, or where it is necessary to develop detailed programs under package authorizations."

Under the revised procedures, to the extent that projects are firmed up by the military departments, lump-sum apportionment action is taken on military construction appropriations under five major program categories. These are (1) public works construction, (2) minor construction, (3) advance planning, (4) supporting activities, and (5) Reserve forces construction.

In order to provide the necessary flexibility, provision is made for submission and approval by the Congress of a program of individual line items plus contingencies that is equivalent to 115 percent of the funding program. The practice of submitting to the Congress a list of construction projects which is greater than the funds requested—sometimes called overprograming—creates an apportionment problem because it frequently takes some time after congressional action to determine the actual program for the year. When this is not practicable, the program is firmed up in increments. As soon as the program as a whole, or specific increments thereof, are firmed up, the apportionments can be made.

The combined effect of improved planning and management of the military construction program and the revised apportionment procedures is reflected in a sharp drop in the number of individual apportionment actions processed during the current fiscal year. With approximately $2 billion appropriated for military construction in fiscal year 1958, the financial plan contemplates a total apportionment program of $2.7 billion and obligations slightly in excess of $2 billion. To date, we have approved a total of 58 apportionment and reapportionment requests, which have released 99 percent of the total apportionment pro-

gram for the year. At the corresponding period of fiscal years 1956 and 1957, a total of 189 and 184 apportionment actions had been taken, respectively.

In conclusion, I would like to point out that section 3679 of the Revised Statutes, which we have been discussing here today, is not a new law. It was enacted in its original form in 1870, almost 90 years ago—and has been continually amended and sharpened by the Congress in an effort to perfect control over the public purse. The law was reenacted in its present form by the 81st Congress, less than 8 years ago, as section 1211 of Public Law 759. It can be said that the history of this legislation is the history of the struggle of the Congress to prevent the unnecessary or wasteful expenditure of public funds.

Chairman DAWSON. We are certainly grateful to you for your appearance, and for the testimony that you have given us, as well as the testimony of your associate. It clears up many points which have been brought before the committee. We are endeavoring to make a study of this subject, and the background of it, for the benefit of Congress, and also hope it will be of some service to the new head of this Department when it is reorganized. It is in the process of undergoing a reorganization, I understand.

Dr. FOOTE. I think your part I was very instructive and very valuable.

Chairman DAWSON. This is a followup on part I. We are very grateful to you for the contribution that you have made, and it will be of inestimable help to the Congress and to the Congressmen in the future, and I hope it will be of some service to the one who is going to head up the new Department in the reorganization.

Mr. LANIGAN. Mr. Chairman, there are certain charts and certain statements which have been submitted by eminent people in the field of research and development to the committee for its use. May we put the charts and the letters in the record at this point, without specifically identifying them?

Chairman DAWSON. Very well.

Mr. LANIGAN. And we will insert them in the printed record.

(The charts and letters referred to follow:)

CHART 1

How the Price of Defense Research and Development Has Risen

(Based on 1947-1949 price levels as shown by Department of Defense Index)

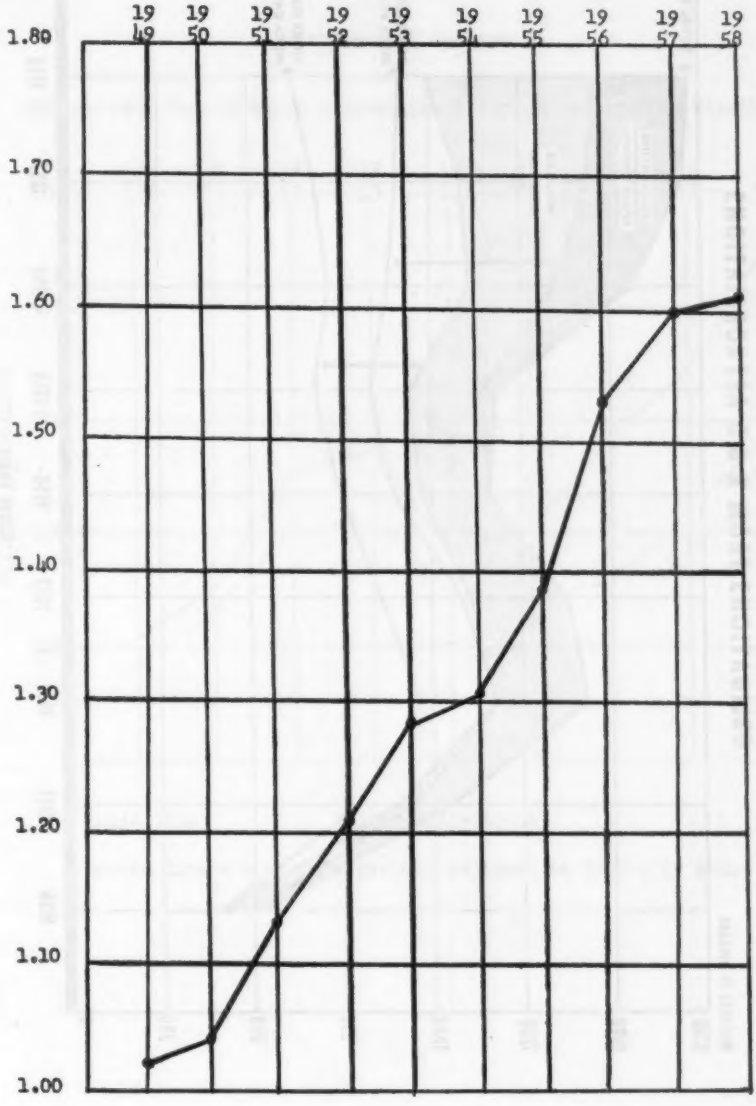


CHART 2

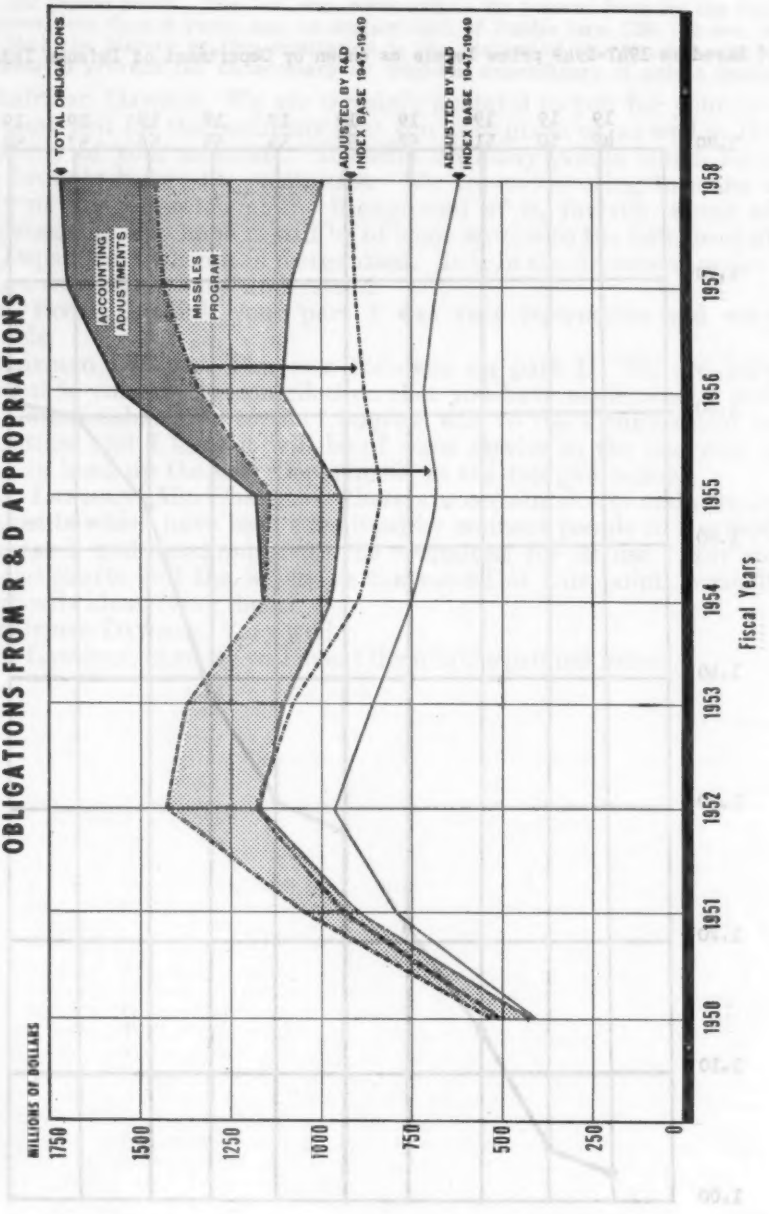
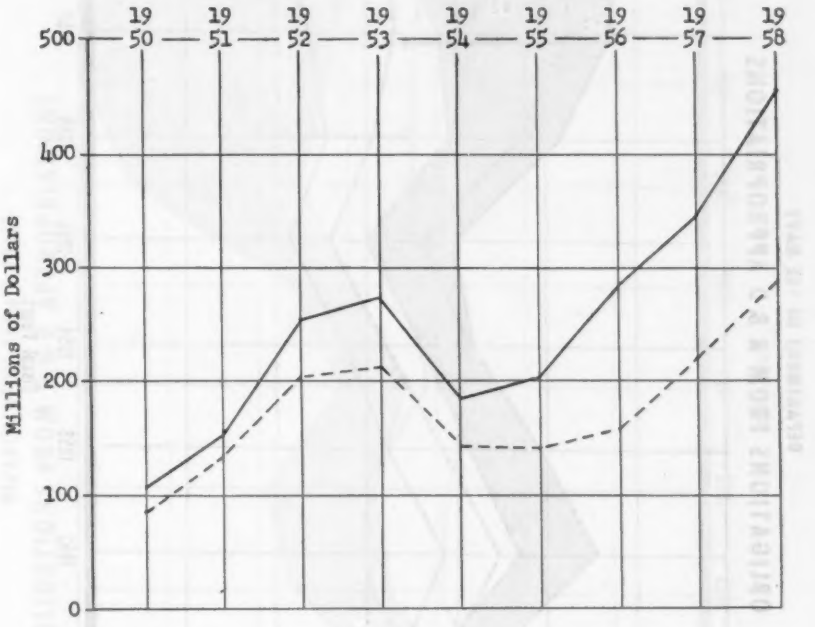

DEPARTMENT OF DEFENSE
OBLIGATIONS FROM R & D APPROPRIATIONS
MILLIONS OF DOLLARS
1750
1500
1250
1000
750
500
250
0
TOTAL OBLIGATIONS
ACCOUNTING ADJUSTMENTS
MISSILES PROGRAM
ADJUSTED BY R&D INDEX BASE 1947-1949
ADJUSTED BY R&D INDEX BASE 1947-1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
Fiscal Years

CHART 3

Department of Defense

Obligations from Research & Development Appropriations for Missiles



Solid line _____ Dollar obligations

Broken line - - - - obligations adjusted to 1947-1949 index base

CHART 4

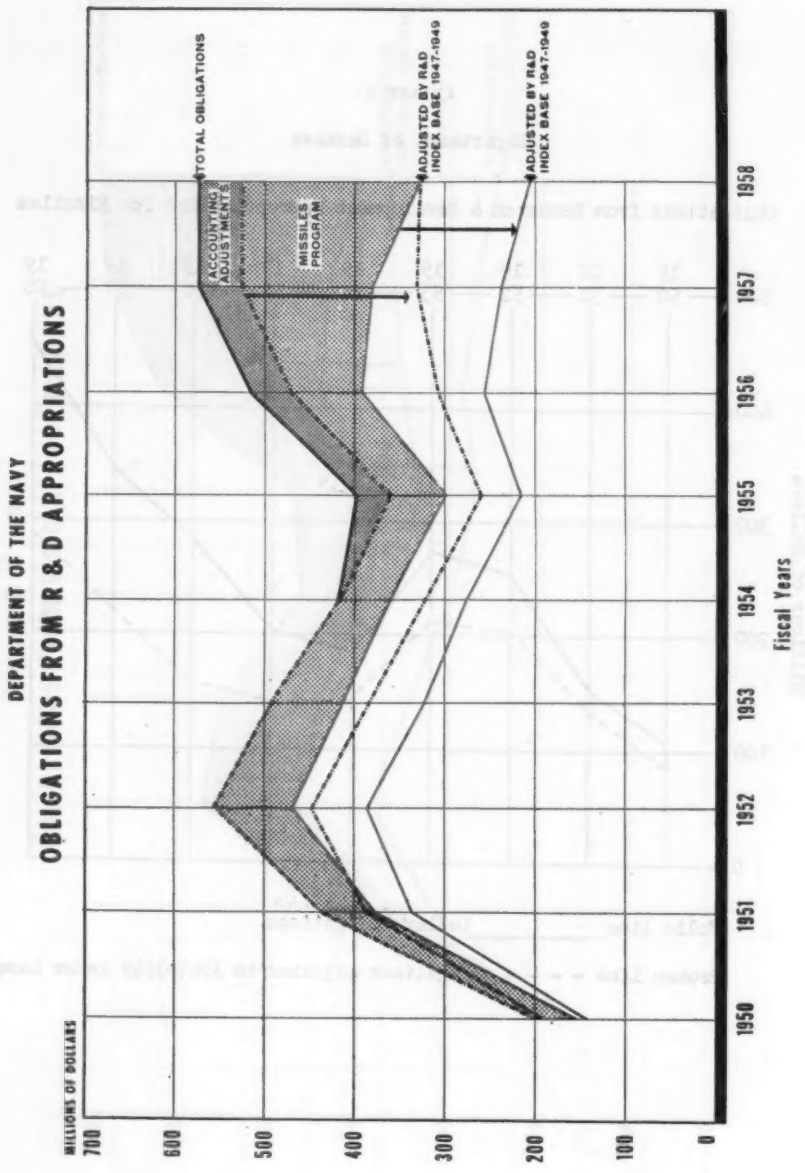

DEPARTMENT OF THE NAVY
OBLIGATIONS FROM R & D APPROPRIATIONS
MILLIONS OF DOLLARS
700
600
500
400
300
200
100
0
1950
1951
1952
1953
1954
1955
1956
1957
1958
Fiscal Years
TOTAL OBLIGATIONS
ACCOUNTING ADJUSTMENTS
MISSILES PROGRAM
ADJUSTED BY R&D INDEX BASE 1947-1949
ADJUSTED BY R&D INDEX BASE 1947-1949

CHART 5

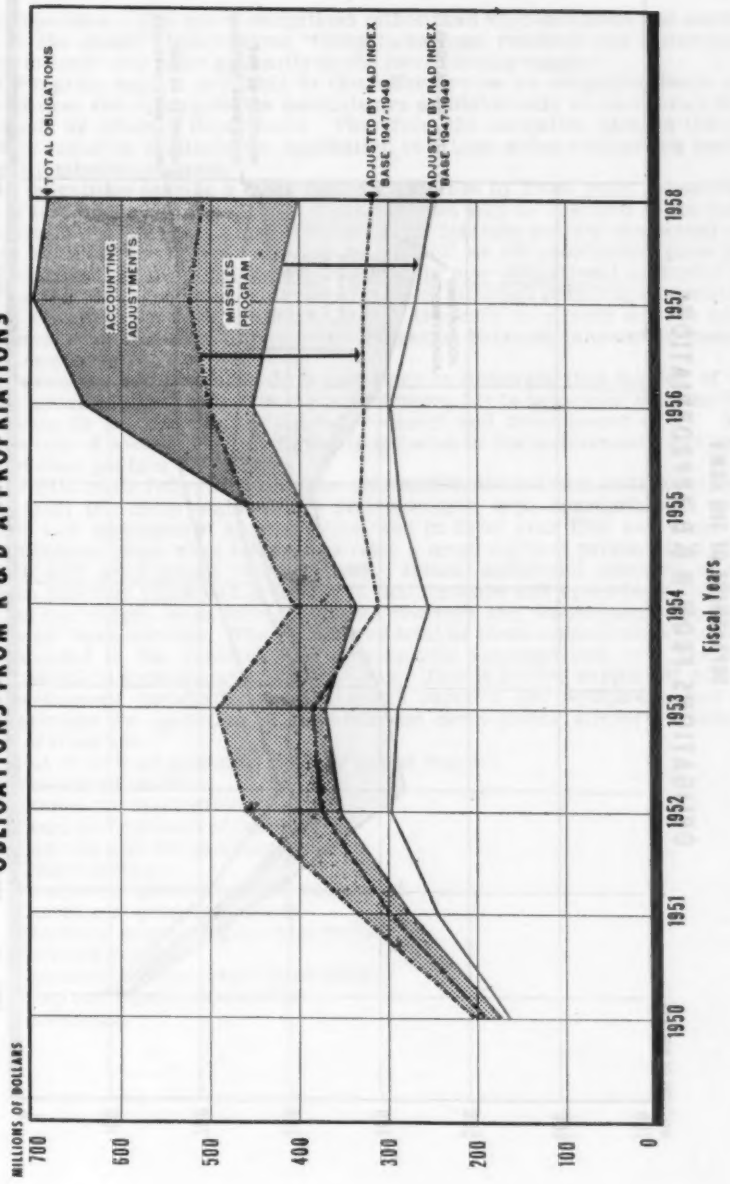

DEPARTMENT OF THE AIR FORCE
OBLIGATIONS FROM R & D APPROPRIATIONS
MILLIONS OF DOLLARS
700
600
500
400
300
200
100
0
TOTAL OBLIGATIONS
ACCOUNTING ADJUSTMENTS
MISSILES PROGRAM
ADJUSTED BY R&D INDEX BASE 1947-1949
ADJUSTED BY R&D INDEX BASE 1947-1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
Fiscal Years

CHART 6

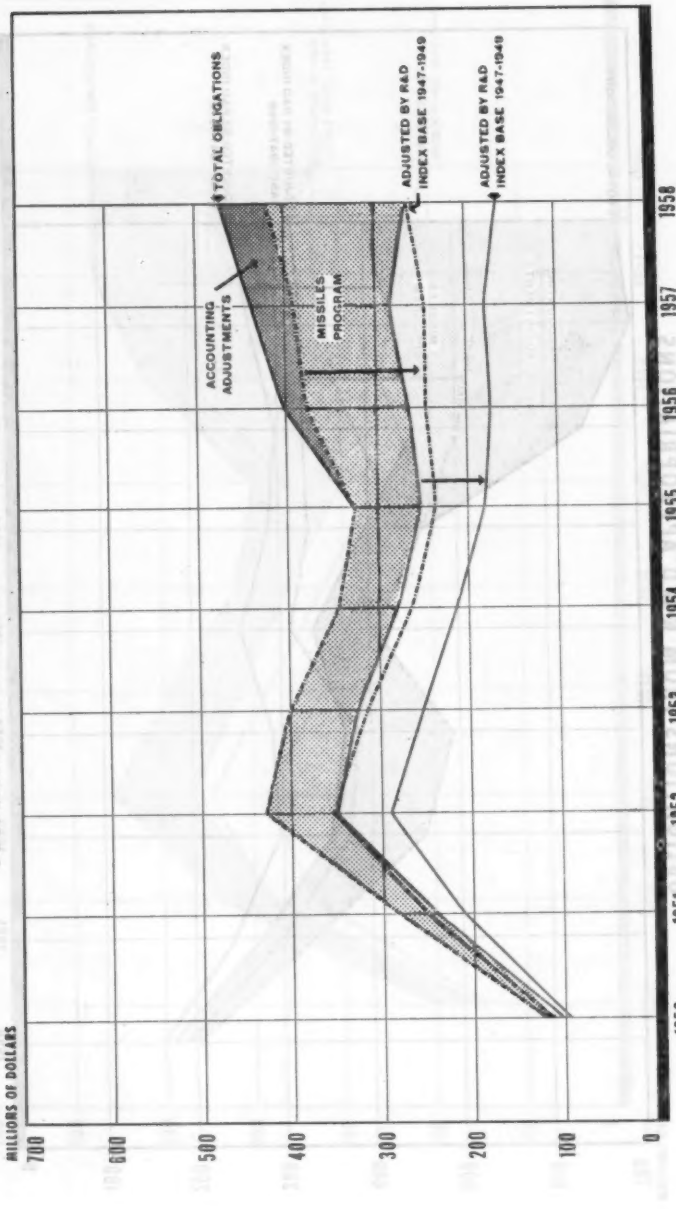

DEPARTMENT OF THE ARMY
OBLIGATIONS FROM R & D APPROPRIATIONS
MILLIONS OF DOLLARS
700
600
500
400
300
200
100
0
1950
1951
1952
1953
1954
1955
1956
1957
1958
Fiscal Years
TOTAL OBLIGATIONS
ACCOUNTING ADJUSTMENTS
MISSILES PROGRAM
ADJUSTED BY R&D INDEX BASE 1947-1949
ADJUSTED BY R&D INDEX BASE 1947-1949

CHART 7

MARCH 14, 1958.

DEPARTMENT OF DEFENSE, OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (RESEARCH AND ENGINEERING)

EXPLANATION OF OBLIGATIONS AND ACCOUNTING ADJUSTMENTS

1. *Obligations.*—The use of obligations rather than appropriations and expenditures in the graphic illustrations "Obligations from research and development appropriations" was based primarily on the two following reasons:

(*a*) Program reports available to this office are on an obligation basis only. Expenditures and appropriation amounts are available only on an overall basis, i. e., totals by military department. Therefore, the obligation basis is the only monetary measure available for application to a time series comparison such as the guided missiles program.

(*b*) Obligations provide a more realistic measure by fiscal year, inasmuch as there is less tendency toward wide fluctuations as may be reflected in the use of appropriations or expenditures. The use of obligations reflects the actual obligations against current year appriations as well as all unobligated prior year appropriations. Appropriations will reflect only new obligational authority provided for the year concerned, while expenditures, although reflecting expenditures against all appropriations available, have a tendency to stretch out the actual effort because of the large unliquidated obligation balances inherent in research and development.

2. *Accounting adjustments.*—It is necessary to illustrate that portion of obligations which represents accounting adjustments. It is important because these obligations do not represent additional research and development effort. They are elements of cost which were formerly included in the maintenance and operation and other parts of the budget.

To explain more fully, in fiscal year 1955 additional indirect costs were transferred from the Navy maintenance and operation type appropriations to the research and development appropriation, and in fiscal year 1956 and fiscal year 1057 additional steps were taken to provide a more uniform presentation of the research and development indirect costs. Hence, additional elements of cost, which in previous years had appeared in maintenance and operations and other parts of the budget, were included in the research and development appropriation for all three services. The cumulative total of these support costs that have been included in the research and development appropriation over the fiscal years 1955–57 is approximately $265 million. This is for the support of research and development installations, nonstandard supplies and equipment, and fuel and lubricants for operation of research and development aircraft. Some examples of these are:

Pay of civilian personnel engaged in test support.
Purchased utilities.
Leased communications.
Local procurement of supplies.
Laundry and dry cleaning.
Utility systems.
Contractor maintenance of equipment.
Leased real property rentals.
Electrical accounting machine rentals.
Security guards.
Commercial transportation of things.
Shop and warehouse repairs.
Pavements.

CHART 8

Department of Defense—Obligations from research and development appropriations

[Millions]

Fiscal year	Obligations	Accounting adjustments	Comparable availability	Missile programs	Available for nonmissile programs	Col. (4) adjusted by research and development index	Col. (6) adjusted by research and development index	Col. (5) adjusted by research and development index [1]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1950:								
Army	$123.0		$123.0	$23.0	$100.0	$117.8	$95.8	$22.0
Navy	200.0		200.0	49.0	151.0	191.6	144.6	47.0
Air Force	202.0		202.0	31.0	171.0	193.5	163.8	29.7
DOD	525.0		525.0	103.0	422.0	502.9	404.2	98.7
1951:								
Army	284.0		284.0	45.7	238.3	252.4	211.8	40.6
Navy	437.0		437.0	61.0	376.0	388.4	334.2	54.2
Air Force	330.0		330.0	52.1	277.9	293.3	247.0	46.3
DOD	1,051.0		1,051.0	158.8	892.2	934.1	793.0	141.1
1952:								
Army	430.0		430.0	78.8	351.2	354.2	290.0	64.2
Navy	543.0		543.0	74.9	468.1	447.3	386.5	60.8
Air Force	459.0		459.0	100.9	358.1	378.1	295.7	82.4
DOD	1,432.0		1,432.0	254.6	1,177.4	1,179.6	972.2	207.4
1953:								
Army	401.0		401.0	74.6	326.4	313.0	254.8	58.2
Navy	490.0		490.0	78.1	411.9	382.5	321.5	61.0
Air Force	493.0		493.0	121.9	371.1	384.9	289.7	95.2
DOD	1,384.0		1,384.0	274.6	1,109.4	1,080.4	866.0	214.4
1954:								
Army	345.0		345.0	63.8	281.2	264.8	215.8	49.0
Navy	416.0		416.0	55.1	360.9	319.3	277.0	42.3
Air Force	404.0		404.0	69.8	334.2	310.1	256.5	53.6
DOD	1,165.0		1,165.0	188.7	976.3	894.2	749.3	144.9
1955:								
Army	325.0		325.0	75.9	249.1	234.5	179.7	54.8
Navy	399.0	$41.0	358.0	59.6	298.4	258.3	215.3	43.0
Air Force	460.0		460.0	64.7	395.3	331.9	285.2	46.7
DOD	1,184.0	41.0	1,143.0	200.2	942.8	824.7	680.2	144.5
1956:								
Army	403.0	26.0	377.0	112.5	264.5	245.8	172.4	73.4
Navy	513.0	42.0	471.0	76.5	394.5	307.0	257.2	49.8
Air Force	642.0	140.0	502.0	45.0	457.0	327.3	297.9	29.3
DOD	1,558.0	208.0	1,350.0	234.0	1,116.0	880.0	727.5	152.5
1957:								
Army	437.0	45.0	392.0	109.0	283.0	245.3	177.1	68.2
Navy	571.0	46.0	525.0	146.2	378.8	328.5	237.0	91.5
Air Force	698.0	174.0	524.0	91.3	432.7	327.9	270.8	57.1
DOD	1,706.0	265.0	1,441.0	346.5	1,094.5	901.7	684.9	216.8
1958:								
Army	468.7	45.0	423.7	159.6	264.1	264.8	165.1	99.7
Navy	570.8	46.0	524.8	195.5	329.3	328.0	205.8	122.2
Air Force	682.5	174.0	508.5	104.1	404.4	317.8	252.8	65.0
DOD	1,722.0	265.0	1,457.0	459.2	997.8	910.6	623.7	286.9

[1] Col. (7) − (8).

CHART 9

Composite of applicable indexes for determining research and development cost index, Mar. 10, 1958

[1947–49=100]

	Percent of total [1]	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958 [2]
Equipment and purchased parts: Machinery and motive products	8	106.6	108.6	119.0	121.5	123.0	124.6	128.4	137.8	146.1	149.5
Materials [3]	4	100.9	107.4	120.2	116.3	117.1	118.2	123.8	128.4	131.6	131.5
Fuel, power, and lighting materials		101.9	103.0	106.7	106.6	109.5	108.1	107.9	111.2	117.2	115.9
Chemicals and allied products		94.8	96.3	110.0	104.5	105.7	107.0	106.6	107.2	109.6	110.6
Rubber and products		98.9	120.5	148.0	134.0	125.0	126.9	143.8	145.8	145.2	144.8
Metals and metal products		104.8	110.3	122.8	123.0	126.9	128.0	136.6	148.4	151.2	150.0
Nonmetallic minerals, structural		104.4	106.9	113.6	113.6	118.2	120.9	124.2	129.6	134.6	136.4
Skilled wages: Manufacturing, weekly earnings [3]	13	103.7	112.0	122.2	128.4	135.4	135.7	144.5	161.2	162.7	149.5
Scientific salaries: Los Alamos survey	27	100.0	100.0	106.5	117.9	126.1	129.3	138.1	153.5	162.1	167.1
Overhead	48	102.1	103.9	111.6	121.3	129.1	131.4	140.2	156.0	162.3	161.4
Research and development index	100	102.1	104.4	112.5	121.1	128.1	130.3	138.6	153.4	159.8	160.0

[1] The above percentage distribution of elements of cost was derived from a sampling of Navy Research and Development contracts.
[2] Based on January 1958 data.
[3] Source: Wholesale Price Indexes, Statistical Abstract of the United States, 1957.

THE GOVERNMENT'S ROLE IN RESEARCH SPONSORSHIP

(Prepared for the Committee on Government Operations, House of Representatives, by E. Finley Carter, director, Stanford Research Institute, Menlo Park, Calif.)

I am grateful to this committee for the opportuity to comment on the use of research by the Federal Government. Your committee work has exposed you to a great deal of discussion about how Federal research efforts should be organized and directed; about the need for research czars, the merits of a department of science and technology, and so on.

How research should be used, however, is a more basic question than how it should be organized, and at the risk of taking liberties with my assigned topic, I wish to concentrate on matters of research use. I do not wish to imply by this concentration that Government research is free of organizational problems. It is not. It is my feeling, however, that you as decision makers can effectively deal with these problems, armed with the information derived from your series of hearings. In my discussion I want to point out some research opportunities, and to outline a philosophical premise which may help you in making your decisions.

The key to this premise lies in the way we define "research." In these technologically oriented times, research has come to be associated almost exclusively with the physical sciences and with electronics. The word suggests test tubes, laboratories, scientific equipment, and the like. This emphasis has had a limiting effect, for great as is the importance of research in the physical sciences, it has other applications which have been underemphasized and largely neglected. Actually, research is a universal tool which may be applied toward the solution of problems in any field of endeavor, in any discipline. It is a method of investigation, characterized by objectivity and directed toward the development of the facts bearing on a given situation. It can be just as helpful in determining the reaction of a human being to a given stimulus as it is in analyzing the reaction of chemicals in a solution. And viewed in this light, research can be used as a technique to help solve a great variety of problems which are now being attacked by guesswork, trial and error methods, and piecemeal approaches.

The contributions of research to the Nation's defense effort hardly need to be emphasized. Our current and projected weapons systems are deeply rooted in

research, and steps are being taken toward the better organization of defense research programs which should result in even greater effectiveness without the necessity for proportionately greater expenditures.

In the Defense Department, research is coming to be understood in the broader sense, as a tool which can be applied to many kinds of problems. It is being used for an ever greater number of tasks, and in ever more sophisticated ways. The Department is now using research to pinpoint its goals with greater accuracy, to evaluate military programs in the light of future threats and probabilities, to develop better means of decisionmaking. It is using research to define those areas in which we should be placing the greatest effort, both in terms of logistics and development of new weapons systems. This broader use is already paying off in better organization, better decisions, and hence in greater overall success.

The Government is using research effectively in defense work, but it is neglecting many opportunities for its application to other fields—fields where it could, if carried on at an effective level, be of great benefit to our country and to mankind. Past threats have impelled the Government into broad and effective research programs in the physical sciences. Today, the Nation is faced with new threats in other areas. They are just as urgent as military problems; they demand a high level of effort and attention. They are problems of communication between peoples; of helping new countries knit the fabric of a good, productive life. They are problems of health, of crime, of "security" in its broadest sense; of extending the concept of freedom so that it becomes meaningful and important to others. These are problems where research can help develop human sciences, where the solutions are to be found in social inventions, just as research on physical phenomena has resulted in physical inventions. Research can make many contributions to the better understanding of the invisible but very real forces affecting human behavior, human relations, and human institutions.

This is not an idle assertion. America's past is rich in social inventions based on knowledge of these forces. Our Constitution is such an instrument. Through the years, it has been supplemented and modified by amendments and laws which were created only after the study and application of basic human principles. As knowledge of these has been developed, the applications have become more refined. In recent years, American corporations have also added to our knowledge of human behavior. They have applied the principles learned to such fields as advertising, selling, public acceptance of the corporation, and labor-management relations—a field in which I was active for a good many years and in which there have been great strides made in a comparatively short period.

Similar research on a Government level could be used to discover approaches to broader problems, perhaps even to those of relations with other countries.

The United States is today confronted with international problems so varied and so complex that an attempt to catalog them would be presumptuous. Likewise, it would be unfortunate to suggest that they can be easily solved, or to underestimate the degree of sophistication needed in approaching them. But the economic and political interdependence of the modern world makes them very definitely our problems, and unless we can get on with their solution promptly and effectively, we must be prepared for the gravest consequences. I believe that research can help, and I would like to suggest a very few areas where it can be of particular assistance.

I. ECONOMIC DEVELOPMENT

The newly developing countries look to America for help, but we do not always know how best to give it. Since we are firmly committed, and I believe rightly so, to helping other countries build their economies and preserve their integrity in the family of nations, we must be better informed on a whole range of questions in this field. To devise intelligent long-range plans and priorities, we need to assess and evaluate current developments levels of all the free world's countries; to know better their plans, aspirations, and hopes. We need to project population and income levels on a country-by-country basis, and for long-term periods. We need to evaluate resources and growth capabilities of these nations, and to determine their needs, and those needs of our own which they can fulfill, not just for the immediate future, but for the next decade or two. We need to do this on an orderly basis, collecting and analyzing all of the information available, and developing new information where it is needed. Only then can we implement our own foreign aid and assistance programs with certainty and good effect.

The social and political institutions appropriate to Latin America may be totally different from those which will work in Asia. On the other hand, experience gained in Nicaragua might be successfully applied to Ghana or Indonesia. Right now, however, we do not know enough about these things. Comparative studies in economic development could establish facts on which to base our developmental assistance. They could help us to undertake the proper kinds of aid programs in the proper places. We would know better how to decide between technical assistance, loans, and grants; how to optimize personnel selection; how to resolve emotionally conceived development aims as against practical reality, and the like. Such research could very possibly lead to new social inventions to help in the task of raising the standards of living in the free world.

There has been considerable attention already given to these problems, principally by private organizations. Because of limited funds, the programs have been limited. They should be supplemented and expanded.

II. FOOD SURPLUSES

Another research challenge is presented by the problem of using our agricultural surpluses as an instrument of American foreign policy. The idea, when it was conceived a few years ago, was appealing and imaginative, but the concept was developed rapidly, and without sufficient facts and research. Neither the Government nor anybody else ever adequately tried to determine, through research, the consequences of massive food gifts to needy countries, in terms of their impact on the recipient country, on ourselves, and on other food-exporting nations. We are learning more about these consequences as we gain more experience, but we are learning the hard way. Our present distribution system has sometimes failed to respond to the challenges of need. It has often had undesirable effects. The gathering and analysis of facts on food distribution would enable the more effective distribution of surplus food, in a way that helps win friends for America, instead of breeding misunderstanding, resentment, and antagonism.

III. AMERICA'S MESSAGE

Aside from our developmental assistance, the United States is spending millions of dollars each year in an attempt to win friends. It is doing this through information and education programs, through cultural and scientific exchanges and the like. Despite some singular successes, we cannot, in all conscience, count the effort as entirely effective. Why? Why do Middle East mobs attack our embassies and other diplomatic outposts? Why do Latin Americans heap vituperation and insult on our elected officials? Why are American tourists the brunt of jokes and insults in many countries throughout the world? There is room for a vast amount of soul searching here. There is ample evidence to indicate that we have often failed because we have neglected to define the ideas and concepts we are trying to impart to others, and we have neglected to package, if you will, these concepts in sufficiently attractive and convincing form. Sometimes, we simply don't know what it is we are selling, or why. Can't we put research to work in identifying our problems in this area, and in developing programs which will achieve this country's goals? Can't we use this tool to help the many devoted people in our overseas information and education programs to do their jobs more effectively?

IV. SUPPORT FOR FOREIGN COOPERATION

Perhaps the most important and the most complex international problem that the United States faces is that of communicating to the American people an understanding of our economic interdependence, and an awareness of the consequences of our acts. Historically, support for programs of international cooperation has been grudgingly given by the American people, and has been difficult to maintain over extended periods. Yet today our leadership is convinced that our very survival as a Nation depends on a greater effort in the international field, and on such a long-range basis that it might as well be termed permanent. In a democratic form of government, however, the conviction of leaders is not enough. The final decisions must be made by the people, and we must see to it that they are informed as decisionmakers. Somehow, the understanding needed for intelligent decisionmaking on international programs must be created. I should make it very clear that I am not advocating an engineering of consent, or a manipulation of mass opinion through propaganda barrages. No responsible citizen could advocate such a course. I have a deep

Jeffersonian conviction that, once the American people know and understand the facts, they will make right and proper decisions. On a political level, it is the duty of the President and Congress to carry the facts to the people. Research can help determine those facts and their significance.

I do not mean to imply present lack of attention to these problems. I am disturbed, however, both by the lack of urgency with which they are being attacked, and the empirical approaches which are often made to them. In view of the urgency with which these problems must be met, the consequences of neglecting the prompt use of all our resources toward their solution will be serious beyond our wildest fears. We must recognize that the Department of State and other agencies are now spending substantial sums on what is, in reality, research, even though it is classified under other titles, such as "intelligence" and "reporting," and is sometimes contaminated with guesswork. The formal research budget of the Department of State in fiscal 1957 was only about $350,000 or, in other words, about 5 percent of the cost of one B–52 bomber. This compares to an overall Federal expenditure for research in that year of about $3 billion—more than 80 percent of which was spent on defense programs of one kind and another. This simple comparison brings into focus the present disparity between research in the human sciences and research on hardware.

In this discussion I have concentrated on international problems because they seem to me to be of the greatest urgency. Let me not leave the impression, however, that the human-sciences approach has application only to the international sector. There are a mass of domestic problems to which the research approach could be applied. We could put a lot of effort into the study of crime, for instance—a blight which costs society some $20 billion each year. We could put research effort on our education program, to formulate the goals we want to follow and the skills which will be needed a decade or a quarter century hence. We could study race relations, slum clearance, dope addiction, and a host of other social problems. We could learn what would happen in the unlikely but hoped-for event that international tensions were suddenly relieved. Here, in particular, research can take the fear out of the unknown by making it known. Research could produce an economic model of what would happen to the United States upon cessation of defense spending. Such a model would enable us to make plans and preparations for the transition to a productive peacetime way of life.

I hope I have made my point. Before we can discuss research organization and research effectiveness, we must decide where, and how, and to what extent, we are willing to apply the tool of research. I have tried to point out the research challenges and opportunities in only a few areas. In dealing with human problems, just as in weapons systems development, intelligent decisions can be made only on the basis of facts.

Research, like any other tool, can be misused, and it would be foolish to extend its application to human problems without careful determination of the priorities, the means of attack, and the level of support needed for each particular program. I am convinced that an extended human research effort must rest on the foundation of sound conceptual planning and direction which would, in effect, constitute the work of a research group itself. Such a group would determine research priorities, needs, methodology, and techniques to be used on international and other problems. This approach will help to reveal gaps in our knowledge, and projects which need to be undertaken. It will also help to determine whether studies aimed at specific problems must be of a slow, long-range nature or a crash program.

Perhaps I have alarmed you by suggesting the need for a program for which research facilities do not now appear to be in existence. It is true that the Government does not itself possess sufficient capabilities to carry out this work. It does not have either the trained manpower or the background of experience necessary to the building of successful human science research programs. This situation is not very different, however, from that which obtained before the Second World War in our Defense Establishment. Prior to 1940, defense research was relatively unimportant. When war created the need for urgent research programs, the military was forced to turn its attention to nongovernmental sources. Through the efforts of the Office of Scientific Research and Development and other groups, industry was mobilized, and the privately developed skills of thousands of scientists were brought to bear on the problems of national security. The system of outside contracting for research worked well for the military. The several services have created administrative groups to insure a permanent system, because it produces results.

Similarly, there exist many nongovernmental sources for carrying on research of the type we have discussed. To some small degree, a few of them are already being used. There are outstanding economics research groups, universities, opinion-research organizations, industrial-relations firms, and the like, which could make solid contributions to a human-research program. There has been some excellent work done by the labor unions themselves. We should mobilize our human-research skills and talents for application to these problems, just as we have so effectively mobilized our engineers and physical scientists for developing weapons and for waging war.

Let us use the research tool in the battle against poverty, ignorance, oppression, and hate. Let us unleash the creative resources of our country toward solving the gravest problems of mankind.

STATEMENT BY DR. ROWLAND EGGER, CHAIRMAN, DEPARTMENT OF POLITICAL SCIENCE, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VA.

No one questions the necessity of accelerating this country's rate of progress in scientific research and development. Agreement on how to do it is less easy to come by. Indeed, some of the proposals which have been made, including certain notions that have reached the stage of legislative consideration, outdo Plato in reaching for the rule of philosopher kings.

In thinking about the problem of governmental organization and procedures for stimulating and expanding scientific research and development, one home truth requires to be kept in mind. This is that there is no such thing as "science." There are only "sciences." The only thing the sciences have in common is what has come to be called "scientific method," which is an attribute they share with intellectual disciplines generally. This means nothing more than that they are rational, i. e., in handling their data they must conform to the rules of logical thought, and that they are empirical, i. e., that they deal with sense data as they are and not as they might be or as the researcher thinks they ought to be. In respect of the prediction of events, the sciences function most successfully with data that can be quantified. Except for this latter characteristic, a biologist has no more in common with a nuclear physicist than either of them has with a lawyer, and rather less than each has in common with a Congressman running for reelection.

I am, accordingly, not very much edified or persuaded by the kind of thinking which underlies a piece recently published in the impeccable New York Times to the effect that "* * * science needs * * * an independent, operational place in the executive structure. Only from such a base can disputes within science be intelligently settled; only from its shelter can scientists speak freely and safely on broad national problems. Though an adviser on science is as necessary to the President as military and economic aides, he cannot take the place of an organized understructure of scientists within Government who can join in the discussion and debate of broad public policy before final decision."

Almost all of the learned professions aspire, of course, to "an independent, operational place in the executive structure," with a Secretary of Cabinet rank. It is largely for this reason that George Bernard Shaw correctly described the learned professions as conspiracies against the public interest. And this aspiration is not without bearing on Charles G. Dawes' correct identification of members of the Cabinet as the President's natural enemies. The Secretary of a Department of Science and Technology, if it were possible ever to appoint one, would of necessity be a theologian, since only divine grace could interpret the cacophonous babble of tongues with which such a department would inevitably speak.

In the first place, the only thing that "scientists" in the mass could possibly discuss with any semblance of rationality and relevance is the pay and working conditions of scientists employed by the Federal Government. That is the only interest they have in common. The Government and its payroll is their only significant common allegiance. They share this allegiance with judges, lawyers, diplomats, clerks, hodcarriers, soldiers, sailors, flyboys, and Presidential assistants. The pay and working conditions of scientists, moreover, however important they may be to the scientists themselves, are hardly "broad national problems." In any case, they can be, and are, fully discussed in many places and on many occasions, quite without reference to any "independent, operational place in the executive structure." The program of every professional association meeting is replete with views on these subjects, spoken as far as I can tell, fearlessly, endlessly, and safely.

In the second place, the notion of a regulatory agency to settle "disputes within science" strikes me as wholly antithetical to whatever authority the idea of scientific method is supposed to convey. The quarrel between quantum mechanics and classical physics will not be resolved by a jesuitical Federal bureaucracy or a royal commission on bickering amongst eggheads, but by the demonstrated superiority of the idea destined to prevail—the construct that explains satisfactorily the maximum range of events. Moreover, disputes are the lifeblood of scientific progress. Far from settling them, it ought to be our sacred duty constantly to fan their flames. I understand that the last time the settling of "disputes within science" was undertaken in any comprehensive way was during the Inquisition, and that the consequences were by no means unanimously agreed to have been salutary from the point of view of accelerating scientific progress. We should not confuse disputes amongst scientists in the several armed services with "disputes within science," although I am not entirely sure just what the latter phrase means. I am sure that the former kinds of disputes can be settled only within established command channels, and that "an independent, operational place in the executive structure" for the disputants can add nothing to the quality of the settlement.

In the third place, the sciences, which are ways of dealing with data, are of importance to the Government primarily from the point of view of the work to be done. Most of the scientific research taking place within the Government, or on contract with governmental agencies, is directed quite specifically toward the solution of particular problems or toward the expansion of "basic" or "pure" scientific knowledge that permit problems to be more clearly formulated. The point is that the scientific research is related to something—something that the Government is doing or in which it expects to be involved. It is from this involvement, actual or potential, that scientific research gains its significance and impetus.

The tremendous importance of the breakthrough in the various sciences, especially nuclear physics, certainly argues strongly for the expansion of support for research and development programs generally. It is equally true that contacts amongst scientists, and the interrelationship of developments in the several sciences, is a matter of utmost importance. But it does not follow that these objectives are best achieved by divorcing scientific research and development operations from the functional agencies which they serve, and putting them into a hodgepodge department of "science" and "technology" which could, under no conceivable circumstances develop a common purpose or program. In short, I believe that the approach to scientific research and development incorporated in the Science and Technology Act of 1958 now under consideration in the Senate provides the least viable solution to the strengthening of research programs and the expansion of the rate of scientific progress generally.

The scientific research and development programs should stay where they are—cheek by jowl with the functions and operating agencies of the Government which it is their purpose to serve. But this is not to say that their accommodations should not be substantially improved, nor that the organization and controls which have been developed for the traditional bureaucracy are necessarily appropriate to operations which proceed in quite different ways and in quite different relationships to their environment.

The essential purpose of administrative organization is to liberate human energies—to set men free, within an agreed jurisdiction, to get on with their jobs without interference. From a structural point of view, its objective is to create, in a pyramidal scale of descending responsibility, units as nearly self-contained, as nearly able to settle matters with which they are dealing, as possible. From a political and managerial point of view, its objective is to establish the formal framework of communication and command by which responsibilities are fixed and coordination assured. From an operational point of view, its objective is to provide a basis for the maximum degree of decentralization consistent with the nature of the work to be done, which is a sine qua non of efficient and economical administration.

The operative phrase in all administrative organization is "the nature of the work to be done." This is the reason, the source, and the sanction of all accommodations in administrative organization. The nature of the work to be done determines the applicability or inapplicability of general standards of administrative organization and control to all activities, including those of scientific research. What is there about basic scientific research that requires accommodation in the structure and processes of administration?

First, the mission of a scientific research operation cannot be defined in the same terms of precision to which a routinized administrative service is subject. To be sure, a medical technician in a general pathology laboratory has a normal load of 10,000 tests per annum, but this is not research, nor does it represent a valid analogy to scientific research, although a large amount of routine testing is frequently involved in scientific research. In a fundamental sense, the basis of organization of scientific research is the hypothesis, the educated guess the scientist makes and then sets out to validate or invalidate. Modern organized scientific research consists frequently of relatively large numbers of individual scientists or teams of scientists working on interrelated hypotheses. But the hypothesis is the basic datum of scientific research organization, because it determines the nature of the work to be done, and how many of what kinds of persons and what kinds and how much of equipment and supplies are necessary to the exploration of the hypothesis.

Second, the requirements of a scientific research operation cannot be precisely forecast in terms of personnel, equipment, materials, or time. Nobody knows how long a series of scientific experiments or researches is likely to go on before a definitive result is achieved, because the problems that may be encountered cannot be foretold. If they could, the research would be redundant. Moreover, developments during the course of research and experimentation frequently dictate drastic revisions of approach, involving fundamental changes of staffing patterns as well as requirements of equipment, material, and supplies.

Third, the results of a scientific research operation cannot be measured in the way in which routine administrative operations are evaluated. A scientist may spend years of time and millions of dollars arriving at a primarily negative result. As far as scientific research and development are concerned, his accomplishment may be almost as important as, although his fame is likely to be less than, that of the scientist who achieves a breakthrough, since it helps define the area of useful hypothesis for future research. All this, of course, is quite apart from the fact that much scientific research has no immediate practical application—although, as recent developments in radio astronomy suggest, it is difficult to forecast when pure research may in fact turn out to be of the greatest immediate practical importance.

What seems to be required in respect of accommodations in organization to the needs of scientific research carried on within the Government is a maximum of flexibility at the bureau level in the basis of structuring research operations and in the recruitment, assignment, and supervision of research personnel. It is not very likely, in view of the differences in the requirements of various kinds of research, that a uniform pattern of research organization for work undertaken within the Government can be devised, or that it would be desirable if it could be. Since the basic datum of the work to be done in research is the hypothesis, more often than not research tends to be organized around the individual scientist leading the inquiry. Within the aggregate of the bureau's facilities for research, therefore, the basic research unit is the individual scientist or the group of scientists working on a specified problem. It is a task force in the sense that the structure and composition is valid, in the main, solely for a particular investigation or series of investigations, and should be subject to liquidation when the inquiry is completed or abandoned. Because much of the work cannot be stabilized from one research investigation to another, or sometimes throughout the course of a single investigation, maximum fluidity in the composition of research teams is essential.

Organizational status of individual scientists, by the same token, tends to be more fluid in research than in administrative organization. A scientist who is an effective leader or participant in one type of research undertaking is not necessarily an effective leader or participant in another. In short, hierarchy in the formal and stable sense in which the term is understood in connection with organizing repetitive administrative work is a much less useful concept in the organization of scientific research. On the other hand, some hierarchy is essential to the accomplishment of any task involving the coordinated efforts of individuals. This suggests that duality of comand and responsibility is likely to be an essential element of research organization—i. e., a continuing line of administrative responsibility, and a temporally variable line of technical or professional responsibility.

I have been much impressed with the testimony previously offered to this committee, which my own limited experience fully supports, indicating that basic research planning and coordination requires to be integrated into the command

structure of the organization at the highest point commensurate with the purposes being served. As I read the record, much of the friction that has developed between Government scientists and their military or administrative opposite numbers, or between contractors for scientific research and contracting agencies, has derived from pitching the planning and coordination process at too low a level—frequently, I suspect, at the same level established for the coordination of applications research and development—in an attempt to get as many as possible of the scientific eggs into one basket. Scientific eggs should not all go into the same basket. They should go where their results support operations planning. In respect of the Department of Defense, I seem to identify a consensus that research planning and coordination at the service and subservice level has produced much difficulty in the administration of basic research, whether on force account or by contract. There appears to be a prima facie case in testimony submitted to this committee for planning and coordinating basic research in the Office of the Secretary of Defense, whereas applications research and development can only be coordinated much lower down. In some sectors of the executive establishment it is likely that basic research can be planned and coordinated most satisfactorily at the bureau or even the division level. But the level at which the planning and coordination take place determines the criteria applied. In respect of basic research, these criteria generally require the broadest possible perspective of the mission of the agency using the research.

Because scientific research in a particular field is very much of a piece, whether pursued as a matter of convenience inside or outside the Government, facilities for articulating and interrelating research is an organizational and procedural consideration of prime importance. If this is to be achieved, four things are prerequisite. First, the salary scales for Government scientists must be competitive with compensation offered outside the Government. Second, a large degree of freedom must be granted to Government scientific research organizations to move outside scientists into the Government and Government scientists to operations based outside the Government. Third, a radical reworking of security arrangements and data classification criteria must be undertaken. Fourth, the field of patent law in respect of sicentific inventions must be carefully restudied and adapted to the facts under which scientific invention actually takes place.

As the previous testimony taken for the committee clearly indicates, the entire area of Government contracts for research likewise requires to be restudied. While the evidence is not entirely clear, it does seem to be true that contracting methods and specifications appropriate to the administration of traditional functions of the Government have been carried over by brute force and sheer awkwardness into the area of scientific research contracting, in which they protect adequately the interests neither of the Government nor the contracor.

In respect of availability of funds, the logic of the operation clearly dictates, and the testimony taken by the committee fully corroborates, the irrelevance of the principle of annuality to appropriations for basic scientific research. This problem has been largely solved, I think, in legislation which has been enacted with respect to the civilian space agency. The technique of devising methods which permit required flexibility with respect to the availability of funds, and at the same time safeguarding the responsibilities of the President and the Congress for the control of the purse, are well within our grasp. What is required, of course, is a set of criteria that will clearly identify what is basic research, to which flexibility of financial and administrative procedures is appropriate, and differentiate it from applications research and development, which are beginning to learn to live within the traditional budgetary and appropriation structure. All that glitters is not basic research. None of us, of course, enjoys the necessity of coming each year for a new appropriation. Many of us would be happier to be permanently endowed and forgotten, if the endowment were adequate. But unless we are to liquidate most of what has been gained in the democratic control of government since the barons wrested the Great Charter from King John at Runnymede, the legislative branch will not lightly abrogate its responsibility for the periodic review of the work and finances of executive agencies. The burden of proof is on the research activity seeking the accommodation.

In a very important sense, the stimulation and acceleration of scientific research by the Government is less a problem of organization, procedures, contracting methods, and appropriations than it is of executive development. One cannot read the hearings of this committee, or of other committees of the

Congress, which have involved consideration of the Government's scientific work, without realizing that the note of frustration recurrent in the evidence of both Government scientists and contractors proceeds, in the main, from a profound lack of familiarity with the way the Government gets its business done. While agency budget, personnel, and administrative people undoubtedly have their blind spots, while the Bureau of the Budget is sometimes impervious, and while the Congress itself occasionally exhibits certain angularities in its treatment of scientists, on net balance the Government is probably the most sympathetic and satisfactory sponsor of scientific research to be found today. What scientist-administrators need to learn is how to use and manage the machinery of government for the purposes they seek to achieve, rather than becoming outraged that in government pi is not always even approximately 3.1416. What is required is a program of executive development for administrators of scientific research—who in our tradition will probably always be scientists—that will fit them to cope with the obverse side of their medal, which is how to handle the administrative and political aspects of getting a job done for the Government.

On the other hand, a great many general administrators who will inevitably have close relationships with scientists and directors of scientific research likewise require to be trained in the history, philosophy, and methods of scientific research. It is as important that the administrative support, and sometimes control of research contribute as effectively to the furtherance of the research as it is that the research support contribute effectively to the purposes of the Government in sponsoring the research. Many of the more successful scientists-administrators have readily assimilated the quaint customs, taboos, and tribal rites of the administrative staff and even of the Congress itself, and some administrators have acquired a working acquaintance with the abracadabra of certain varieties of scientific thought. Much of the frustration of scientists with the Government, and most of the administrative staff's impatience with the peculiarities of scientists, would be ameliorated if a larger common basis of understanding could be developed. The Brookings Institution, in its current executive development program, is making a significant experimental beginning on this problem. The experiment should not be allowed to lapse.

LETTER TO CHAIRMAN WILLIAM L. DAWSON FROM PROF. LOWELL H. HATTERY, SCHOOL OF GOVERNMENT AND PUBLIC ADMINISTRATION, AMERICAN UNIVERSITY, WASHINGTON, D. C.

THE AMERICAN UNIVERSITY,
SCHOOL OF GOVERNMENT AND PUBLIC ADMINISTRATION,
Washington, D. C., July 30, 1958.

HON. WILLIAM DAWSON,
Chairman, House Committee on Government Operations,
United States Capitol, Washington, D. C.

DEAR CONGRESSMAN DAWSON: I appreciate your invitation to comment on matters of concern to your committee, and indeed to the Nation, in the area of research organization and administration.

In our training and research programs at American University we have given attention to the full range of issues, organization, and methods for the effective conduct of research in the public service including the military service. These are matters so fundamental that it is desirable and, in fact, essential that the legislative branch give them continuous systematic and professional attention. Such attention, external to the executive branch, has in the past generally been glancing and transitory. The issues are too vital to the future survival of our Nation to be so treated. I hope your committee will continue study and scrutiny of Federal research organization and administration on the high level, nonpartisan professional basis which our national welfare demands.

In this letter I shall not attempt to treat the many subjects with which the committee is concerned. Instead, I should like to make these brief observations from the point of view of a professor and researcher in research organization and administration:

1. Top-level organization for research and development activities is important. But even more important to the total research productivity is planning, organization, manning and administration or supervision at intermediate and lower levels. Any program to strengthen our research endeavor must therefore extend throughout the research administrative process from bottom to top.

2. Systematic research on the research administrative process should be given much more support than at present. Unfortunately many believe, including some leaders of science activities, that the administrative process is not researchable in the way that other areas of natural and social behavior are researchable. These same persons will complain futilely about defects in the administrative process. The following quotation describes a point of view about this matter: [1]

"We believe that management methods of business or government, including the military, must be changed when applied to research administration. In no other area is this fact so important as in the organization of personnel participating in a scientific research project. It is here that the team concept is vital. The achievement of a successful combination of persons assigned to the project requires at least three major components: (1) Maintenance of leadership in some degree, (2) recognition of the necessary staff processes of administration, and (3) development of the fullest individual participation in those areas of individual competence pertinent to the research problem.

"We suggest three types of effort for the extension and improvement of teamwork in scientific work in the United States and for the increase of creative productivity of the scientific task force. These suggestions are: To further research into the nature of teamwork and of creativity, to train in research administration at all levels and to develop means for effective communication in research activities.

"*Investigation in research administration*

"Despite problems of large magnitude and significance such as we have outlined, there is little support for investigation in research administration. In the early 1950's the Office of Naval Research supported pioneer work in this area, and the National Science Foundation is currently supporting some studies. They are remarkably restricted, however, when one considers the potential payoff for improved arrangements and processes for administering research programs and projects.

"There are many possible approaches to investigation in research administration. Major emphasis might be directed toward more knowledge of the individual engaged in research, toward the nature of small-project group relationships, and toward the study of the relationships between the researcher and the administration.

"An extensive myth has arisen about the scientist, and this myth should be put to the test of close study. Is there a generic scientist who reacts and thinks creatively according to generalized rules and situations? Or does each scientist behave unpredictably as an individual? Or are there X categories of scientists, each category responding in predictable ways? How does one identify the categories? What are the ranges of behavior? What are the environmental factors which produce the greatest probability of realizing creativeness?

"What combination of individuals make up the most productive research group? Will a group of highly competent scientists who tend to be asocial produce better than a group of less highly competent scientists who tend to be social? What is the relative importance of adding a new specialist to the team compared with adding a new teamworker whose specialization is already represented? What is the relative significance of technical competence and the intensity with which scientific attitudes are held, in terms of creative productivity? How is the scientific attitude developed and intensified? How can the administrative personnel be helped to understand scientific attitudes and scientific methods? How can the balance between control and freedom be achieved? When does aid to the scientist reduce the scientist's own control over his research? What are the optimum arrangements for the researcher's participation in planning, operating, and reporting research activities?

"These questions are suggestive of directions that study might take into three areas of research administration: The individual, the group, and the administrative organization. Such research is vital to the achievement and improved understanding of teamwork."

3. As an educator, I have a special interest in the contribution which training can make to more effective public administration. I have been particularly concerned with the problems and the potentialities of training the mature person who is about to enter or who is already in an administrative position.

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[1] George P. Bush and Lowell H. Hattery, Teamwork and Creativity in Research, Administrative Science Quarterly, December 1956, pp. 368–369.

Training in research administration is a critical current need. The research administrator usually comes from formal training in science and engineering without any introduction to the science and the art of management. In fact he is often hostile to personal concern about administration. Yet scientists and engineers have been cast by the fortune of research program growth into positions of tremendous administrative responsibility. Some have learned to swim by themselves surprisingly well. Others have not. All would undoubtedly benefit from some systematic attention to self-training or external training in administration.

Following is a brief outline of training areas which should receive attention:[2]

"(1) *Administrators without training in science.*—Line administrators in direct supervision over personnel trained in science and staff administrative employees not trained in science need to have training in the nature and history of science and indoctrination in the scientific attitude. Formal training in organized courses and seminars can bring to their attention the benefit of what is already known about administration.

"(2) *Administrators trained as scientists.*—These persons especially need formal training in research administration. They tend to apply too mechanistically the methods of administration they have observed or read about in nonscientific enterprises. Paradoxical though it seems, scientists very often become highly autocratic and inflexible administrators. One might say that scientist administrators are too often unscientific administrators.

Scientist officials need formal training through seminars and courses in both general administration and research administration.

"(3) *Project supervisors.*—These scientists are only part-time administrators whose principal administrative function is the supervision of a group of technical personnel. Although training courses in general administration and in research administration would be helpful to them in working with other administrative personnel and in preparing themselves for administrative positions, the prime need is to teach them the rudiments of group relationships. Training in the nature of individual motivation and in the dynamics of group relationships is important and may be achieved through the traditional courses in supervision adapted to the research situation.

"(4) *Bench scientists.*—The nonsupervisory scientist should be given some training in the nature of administration and of group relationships in organized endeavor. The frustrated bitterness of the supervised about "administrative redtape and stupidity" is no aid to creative activity. Understanding of the administrative necessities of life and of the essential nature of the teamworker should result in better teamworkers at the production level. No extensive training is called for, but an orientation as indicated is desirable.

"There is no one agency or means for conducting the training for the four groups of personnel described. The training may consist of formal courses in administration available from most universities and formal courses in research administration now offered at universities in most of the important research communities, including the University of Pennsylvania, the University of Chicago, Columbia University, and American University. Training may be offered by the organization as inservice training with instruction from either the staff or invited instructors. The use of contracts with university staffs to offer tailored courses within research organizations has relatively unexploited potential.

"One of the difficult problems of training is to find instructors who themselves have an understanding both of traditional administration and of the nature of research. Engineering or industrial-management training does not qualify a trainer in research administration. For example, a schedule is one of the most important tools of the industrial engineer. It is also an important tool of the research administrator, yet in research the schedule must not be master. If it becomes the master, progress may be blocked. So the search for research trainers should be directed toward finding the person who has an understanding both of administration and of research, that is, of research administration."

In concluding, I do not want to leave the impression that nothing is being done about the matters I have presented. Many persons share my concern and much progress is being made. I have just returned from England where I talked with leading science administrators in industry and government about these and other topics. There as in the United States there is growing accept-

[2] Bush and Hattery, op. cit., pp. 369–370.

ance that "organization and administration" are truly matters of substance and provide tools with which the scientist can be provided the maximum opportunity to contribute to progress in scientific knowledge and technological development.

Respectfully yours,

LOWELL H. HATTERY,
Professor, School of Government and Public Administration.

CARNEGIE CORPORATION OF NEW YORK,
New York, N. Y., July 8, 1958.

Mr. WILLIAM L. DAWSON,
House of Representatives, Committee on Government Operations,
House Office Building, Washington, D. C.

DEAR MR. DAWSON: This is, indeed, a belated response to your letter of April 7. I regret that other commitments have kept me from replying at an earlier date.

The essence of my views as to what is needed to improve governmental organization for research and development has already been noted in other quarters. For example, in hearings before the Subcommittee on Fiscal Policy of the congressional Joint Economic Committee (November 18–27, 1957). I noted that sensible Federal expenditures policies for research and development are contingent on the development of sound Federal research programs. These are, in turn, contingent on Federal policies governing research which are flexible, imaginative, and designed to meet the research needs and responsibilities of the Government and the Nation. It was then noted that confusion and lack of leadership were the order of the day with respect to science policy and that some device such as a Council of Science Advisers in the Executive Office of the President seemed to be called for.

Later in commenting on the proposal for a Department of Science, contained in S. 3126, I wrote to the Senate Committee on Government Operations (Document No. 90, 85th Cong., 2d sess.). Again the burden of my remarks was that there is a most urgent need for science policy leadership. Contrary to the views of many scientists, I felt that a Department of Science would offer a means of assuring Cabinet-level attention to this most important area. I may note in passing that the principal attack on the Department of Science idea seems to have been that it is unwise to integrate in one department all of the scientific research activities of the Government. With this objection I concur, since it would be utterly impractical to remove from their functional associations the vast applied and developmental programs of such departments as Defense, Agriculture, and Health, Education, and Welfare. But, unless I have misunderstood S. 3126, it made no such sweeping proposal and I have been at a loss to understand the apparent misunderstanding of this bill by much of the scientific community.

The essential issue still is how we can organize in the Federal Establishment to provide the kind of science-policy leadership which must be forthcoming if we are to meet our national and international responsibilities. While it is difficult to keep informed when one is removed from Washington, and while the information available to the public is, at best, fragmentary, I have noted one recent development which is most heartening. On June 22, Dr. Killian's office released information which indicated that the most pressing of the Government's science problems are now being given adequate attention. The release went on to say that it is thus possible to begin to think about a longer term blueprint of where the Government should be moving with respect to its scientific research activities. This suggests that some policy guidance of real substance may, in time, begin to emerge from the Killian office.

In view of the fact that Dr. Killian's appointment was in response to a crisis situation, and was not a carefully planned and thought-through arrangement, I have been skeptical that it could provide the permanent base of policy leadership in scientific affairs which is so sorely needed. If, however, the Killian operation is, in fact, able to move beyond meeting the immediate crash problems of the postsputnik months, it should be given every support and encouragement.

It appears, therefore, that a committee, such as the House Committee on Government Operations, if it agrees that the problem of science-policy leadership is a central one in the executive branch, would want to examine carefully

the role of the Killian office to date and its potentiality for providing, in the future, needed policy leadership. If the progress of the Killian office is as promising as is suggested by the aforementioned release, it would appear wise to forgo action on other kinds of policy arrangements and to provide full support for Dr. Killian's activities. It can be attested, from firsthand experience, that an agency or office which is dealing with the public issues of science must be adequately staffed to keep informed about the vast activities of the Government in research and development, and must also have the resources to conduct, or contract for, research on the problems of research and development in the Government and in our society.

There is, perhaps, no more concise way to state my views on the conditions which must surround effective processes for the formulation of Federal science policy than to quote from a talk given to a Cornell University symposium on the effective administration of research programs, in April of this year:

"First, a unique kind of leadership is demanded. The principal spokesman or spokesmen for science must have the acceptance of the scientific community at large. This is not easy to come by. At the same time, there must also be an appreciation of the intricacies of the democratic process, of the role of the Congress, of relationships between President and party, President and Cabinet, and President and Congress, of the value of debate and conflict in resolving national issues. This is not easy to come by, especially for a scientist who is respected by his peers.

"Second, for the Government the ultimate arbiter of policy is the public interest. This demands the development of wide consensus through very extensive consultation and compromise within and outside of Government. The governmental practice of using many advisory committees and of holding endless committee meetings is symptomatic.

"Third, no simple criteria of costs and profit potential can ring the judgment on the effectiveness of public policy. Facts in vast profusion are needed to shed light on many aspects of every public issue related to science. But beyond the facts must be the courageous, perceptive, sophisticated application of judgment—in short, statesmanship of a very high order.

"Fourth, as for the facts that are needed, there must be means for the mobilization of data and information, both for the problems of immediacy and for those which are showing themselves on the distant horizon. This means money and institutionalized devices for data gathering and for research on policy issues of science.

"And, finally, there must be organizational arrangements which place the formulators of science policy close to the apex of governmental responsibility, both formally and de facto. Otherwise, conflict from beneath cannot be resolved and communication to the ultimate sources of decision will be faulty."

While I realize that I have addressed my remarks to only one facet of one issue raised in your communication, it is hoped that they may be of some use.

Sincerely yours,

JOHN C. HONEY.

STATEMENT OF J. DONALD KINGSLEY

We are today in the midst of a revolution far more profound than the industrial revolution, and one which is moving at a much faster pace. In both instances, scientific breakthroughs achieved through basic research—with a subsequent mushrooming of technological development—were the prime movers. But the breakthroughs in our generation have been so much more profound, and have followed one another with such rapidity, that their combined impact threatens the very fabric of society.

The direction, character, and progress of scientific research is today an overriding determinant of economic development, of social relations, of foreign and military policy, of national survival and, perhaps, even of the survival of mankind.

This central, revolutionary role of scientific research also profoundly affects the structure of government and the character of administration, while the approach of government to science has, in turn, a profound effect upon the direction and progress of scientific research.

Your committee is, thus, examining into one of the core problems of the age in which we live.

I should like to start my own analysis rather broadly. It seems obvious to me that any activity or pursuit—or the application of any body of knowledge—so potentially explosive and so demonstrably related to national survival and to every aspect of public policy, cannot be left to the experts and the practitioners. Just as war is far too serious a matter to be left up to the generals and the professional soldiers, science and scientific research have far too serious implications today to be left to the scientists, however much they might hope to the contrary.

This conclusion is reasonably clear when we look at the problems involved from the top side of the executive branch—say, from the White House or the Department of State. Dr. von Braun—to pick an example only for purposes of illustration—may feel certain as a scientist and engineer that we can hit the moon with a ballistic missile. He may, as a professional, also feel certain that such an undertaking would produce useful, or even important, scientific information. As a scientist, also, he may understandably wish to test his theories and his calculations in the laboratory of space. These would be legitimate interests and legitimate points of view for any scientist or development engineer working in the field.

But a decision as to whether or not to shoot the moon, or as to when such a shot might be undertaken, obviously involves far more than such legitimate scientific interests. It involves the expenditure of vast sums of public money; it involves the allocation of scarce resources, including the diversion from other efforts of scientific and engineering manpower in short supply; it involves determinations of relative utility and priority in the light of considerations of military and foreign policy objectives, psychological warfare, and many more.

These overriding questions of public policy are political and administrative questions, not scientific ones. In a democracy, they can be resolved only at the political level, and the decisions thus reached can be carried out only through administrative channels and organization. The scientist—as a scientist—can neither take the decisions nor legitimately claim a right to do so. Nor—as a scientist—can he allocate the resources and personnel and take the administrative steps necessary to carry out the decisions. All that he can legitimately demand as a scientist—and the responsible politician or administrator would wish no less—is that there be adequate channels of communication to the political and top administrative levels, so that his arguments and information may have their appropriate weight in the decisionmaking. To provide such channels is, in itself, a challenging administrative problem.

I think the average person—and, probably, the average scientist—would accept the principle that, when research and development so manifestly bear on major questions of public policy, the scientist must be subject to political and, therefore to administrative controls. It is, perhaps, less easy to see this in areas of research less spectacularly related to major policy issues, or from a perspective at lower levels of the administrative hierarchy—say, at the bureau or division level. But every public policy is, by definition, of significance to some group in our society, and I believe the general principle of political and administrative control must apply at every level and without regard to the type of research or its subject matter.

But, while the principle must apply generally in a democracy, the tightness, directness, and form of administrative control can and should vary widely. The biologist working on diseases of the oyster can be allowed far more freedom and be less hampered by administrative controls than can the atomic physicist. This is not because there is any difference in his functioning as a scientist—and this point is important. From the standpoint of the advancement of knowledge and in terms of pure science, the biologist and the nuclear physicist are equivalent. But the work of the one is more palpably and urgently seized with a public interest at the present moment than that of the other. For that reason—and that reason alone—the work of the one will necessarily be subject to more stringent direction and control.

This brings us to the heart of our dilemma, for the frontiers of knowledge are pushed back by a process demanding a maximum of freedom for the creative scientist. No one can say, with any certainty at all, what lines of inquiry will be fruitful and what sterile, or when a major breakthrough will come by chance. Results are, thus, most likely if the creative scientist is left to his own devices and is allowed to communicate freely and to draw stimulation from his colleagues.

Yet, in the world in which we live—a world in which our survival depends momentarily upon the progress of research and development—we can approximate the optimum conditions for scientific productivity only in the oyster area. The more closely related to national survival a research project is, the less easy is it to provide the conditions for a successful research effort. This is the challenge—the very basic challenge—confronting both scientists and administrators today.

We have not yet succeeded in meeting this challenge, but I am confident that we can do so. It will require the invention of new forms of organization, a careful differentiation of the respective partnership roles of the administrator and the scientist at every level, and the development of a new breed of scientist-administrators or of research administrators to occupy the sensitive and crucial positions linking the working scientist with the upper reaches of the political-administrative hierarchy. This, in itself, requires new and imaginative methods of recruitment to the career service and distinctly new programs of inservice training.

In keeping with our strongest traditions, we have already shown imagination and adaptability in the creation of a new mixed economy in the research field. This has occurred not only through a remarkable extension of the contracting process—through which the direction and output of the most individualistic of American enterprises are in fact socialized—but also through the development of entirely new quasi-public research agencies like the Rand Corp., associated with the Air Force; the Atomic Energy Commission's Associated Universities, Inc.; the tremendous quasi-public laboratories operated by individual "select" universities—the Argonne at Chicago; the Lincoln Laboratory at the Massachusetts Institute of Technology; the Los Alamos Laboratory managed by the University of California, to mention the most prominent. In all of these, Federal financing and Federal Government direction in the broad sense play the primary role.

In fact, the Federal Government today is far and away the major influence, almost the prime mover, in scientific research in this country. This is a recent development, dating back no further than World War II. In the era of the sputnik, this is a fact of the most profound and sobering significance. It is a fact, moreover, which has not yet been grasped in its enormity by our people nor, with all due respect, by our political leaders. What has, in fact, happened—in response to inescapable challenges to our national survival in recent years—is that we have socialized, without knowing it, the revolutionary catalyst of our age. The responsibility which this places upon all elements in our governmental system is beyond any known in the history of the Republic.

But while this is a sobering and even disturbing fact, I doubt that this development could in any way have been averted. Meanwhile we have, in a manner perhaps unique to us and to the British, stumbled upon a promising road. For we have created no monolithic scientific research structure in the Federal Government, no central Department of Scientific Research; no central arbiter of research programs (except as the Bureau of the Budget serves as such).

Instead, we have fostered in the fields of research and development one of the most striking pluralistic developments in the history of our country. We have thus maintained, even with a large degree of socialization, a variety of centers of initiative and a strong element of free competition. To some, the result (particularly when the bureaucratic wrangles of the various services are highlighted) appears wasteful and chaotic. I, for one, am sure that it is not. Pluralism in organization and approach, even if occasionally acompanied by chaos, is fundamental to scientific progress.

I, therefore, regard it as good that—in addition to quasi-public institutions and to a large-scale contracting program—we also maintain and operate great Government laboratories like the Bureau of Standards or the National Advisory Committee on Aeronautics (now in process of transformation into a "Space Agency"). I also think it wise that the Congress did not clearly and unequivocably resolve the question of civilian or military influence in the direction and control of the new agency devoted to research along the frontiers of space. Conflicts of interest may confuse and even infuriate an individual scientist. In the long run and in our present situation they will advance science if there is adequate overall direction to keep them within bounds. In this respect the controlling role of the White House is obviously crucial.

In a brief statement I cannot, even if I had the current knowledge, adequately illustrate this significant pluralism which distinguishes our approach from most others and which, I believe, will enable us to surpass all other countries if properly supported and sustained by the Congress and the Executive. Let me additionally mention only the National Science Foundation (the potential significance of which has not yet been grasped by our people or our Congress) and the National Institutes of Health, which are models for all of the world. Upon these two institutions, in particular, rest our national hopes for that revival in basic (fundamental) research without which we must forever be followers, rather than leaders.

This point is crucial; and it is one on which congressional and Executive leadership is urgently needed. We are, in many respects, a complacent people as a result of the enormous advantages we have enjoyed of abundant national resources and geographic isolation. But our phenomenal progress was due not only to such factors as these, but also to the fact that most of our national history corresponded with a period in which there was a free exchange of ideas in the civilized world. As a result, we freely imported our science, our basic ideas, and exported the products of its technological application. Despite some obvious exceptions, we have not been notable for basic discoveries, largely because we did not have to be.

That situation is unhappily completely altered. Within a generation, the universality of science has been shattered and obstacles have everywhere been erected to the free exchange of scientific information. (This atmosphere has, of course, even affected the exchange of information among our own scientists. Such a result is suicidal in the scientific competition in which we are now engaged, for scientific progress depends upon the maximum freedom in the exchange of information and ideas.)

Any national science policy, and we have urgent need for a coherent one, must be built in the first instance upon the clear recognition that technological advances depend upon fundamental research and that we no longer have free access to the ideas and discoveries of scientists around the world. We are now, for the first time in our history, thrown back largely upon our own resources for fundamental breakthroughs. A national science policy will, therefore, look first of all to methods of stimulating and encouraging basic research and the training of more scientists capable of functioning in this highly creative area. We have at hand an administrative instrument for this purpose in the National Science Foundation. All we need to do is to use it imaginatively.

But we need more than this if we are to develop a national science policy, and an administrative structure to effectuate it, equal to the challenge confronting us. While I firmly believe that a pluralistic approach will be more fruitful in the long run than any monolithic structure, it is still true that we have not really evaluated the various approaches we are making to this problem. We have not, in fact, had any really serious study of our governmental research effort, either in terms of its content or of its organization, since the 1947 report of the President's Scientific Research Board (Science and Public Policy). In terms both of basic science and of technology, the intervening years have been prodigally fruitful.

It is, I believe, time for another comprehensive review of the entire Government effort in the fields of research and development—a review which would assess the current balance between the research and development sectors, the military and civilian sectors, the level of the scientific effort in relation to our financial and personnel potential, the status and state of scientific manpower, and the general effectiveness of our various approaches to research.

Such a comprehensive review should not neglect the administrative and organizational aspects. Recruitment, budgeting, appropriation and fiscal control systems applicable to the Government as a whole are, I believe, demonstrably inapplicable to basic research programs. To an considerably lesser degree, they are inappropriate to many development programs.

All of these things should be examined without delay by a duly constituted commission. We need, for the guidance of us all and for our very survival, a coherent and forward-looking national science policy. And we need to review critically our legislative and administrative procedures and practices to make such a policy effective. I hope, Mr. Chairman, that you and your committee will undertake to assure that such a comprehensive survey is undertaken.

LETTER FROM PROF. JOHN W. MASLAND, DEPARTMENT OF GOVERNMENT, DARTMOUTH COLLEGE, HANOVER, N. H.

DARTMOUTH COLLEGE,
DEPARTMENT OF GOVERNMENT,
Hanover, N. H., April 21, 1958.

Hon. WILLIAM L. DAWSON,
Chairman, Committee on Government Operations,
House of Representatives,
House Office Building, Washington, D. C.

DEAR MR. DAWSON: Thank you for your letter of April 9 inviting me to submit a statement in connection with the study of certain phases of the research and development activities of the Federal Government.

Unfortunately I have not been concerned with this matter in recent years and have only a layman's impression of the present organizational and budgetary aspects of the problem. I am not in a position to provide useful comment for your committee.

As a result of work done in the preparation of a book on military education (Soldiers and Scholars, Princeton, 1957), I concluded that much could be done to strengthen instruction at the senior military schools to equip professional officers for work in scientific areas. My comments on this will be found at pages 383–387. (See attached excerpt.)

Likewise, I feel that the educational preparation of civilians for policy level roles in the Government provides inadequate attention to the implications of scientific and technological developments for policy issues. I hope to commence a study of this matter before the end of this year. I presume, however, that these are matters beyond the present scope of your inquiry.

Sincerely,

JOHN W. MASLAND.

SCIENTIFIC RESEARCH AND DEVELOPMENT

This discussion indicates that the joint and service colleges give clear recognition to the necessity of examining critically all doctrine, organization, and practice in the light of technological change. The question remains, however, to what extent they give the students a full appreciation of what might be called the "scientific dimension." In chapter 2 we suggested that the general line officer assigned to policy levels needed insight into the relationship of scientific research and development to strategic planning. Since the joint and service colleges prepare officers for assignment to strategic planning and related activities, it is pertinent to examine their instructional programs in this area. Before doing so, we should point out again that it is not the function of these institutions to provide scientific specialist training for professional officers. This is accomplished largely through the assignment of officers to civilian institutions for graduate study and through special programs operated by the armed services themselves, such as those of the Air Force Institute of Technology at Wright-Patterson Field. We are not interested here in the training of specialists, but rather in the preparation of officers at policy levels for handling the scientific or technological factor in the course of their responsibilities.

The initial plans for the curriculum at the National War College appear to have been based upon a conviction that high-level planners should be prepared to deal with problems of a scientific nature, such as the impact of new weapons. These plans were prepared during the first year after the atomic bombs were dropped on Hiroshima and Nagasaki and shortly after the tests at Bikini. The situation was explained by Admiral Hill, the first commandant, in testimony before a House committee several months before the opening of the institution. He said that the program would commence with lectures by scientists regarding the meaning of the new scientific age, and on how we must orient our thinking on industrial, political, and military matters. He explained that the college would not try to make mathematicians or scientists out of the students, "but we want to inform them in the development of scientific progress and inform them of what may be expected in the next 4 or 5 years." Subsequently the definition of the scope of the program, as approved by the Joint Chiefs of Staff, indicated that it would include study of "the influence of the possession

or deficiency of economic, scientific, political, and social resources upon the capability of waging war, and of the impact of science and technology upon the Armed Forces."

For the first 3 years the National War College program opened with a 1-week course on the atomic age. The next year this was moved to the second week. As designed in that year the course consisted of lectures on the atomic age, the impact of the atomic bomb on warfare, the magnitude of atomic bomb development, international control of atomic energy, and the United States Atomic Energy Commission. The following year this was dropped as a separate course. The purpose in scheduling the course early in the year had been to dramatize the impact of atomic developments on human affairs. After 4 years it was felt that this emphasis no longer was required, since the implications of the atomic age were fully recognized by mature officers. During this period attention also was devoted to technological developments in connection with discussion of other new weapons.

More recently at the National War College direct attention to science and technology has been associated with consideration of the latest developments in weapon systems. Separate lectures are given on nuclear energy and classic doctrine, nuclear politics (political blackmail and bribes), nuclear electronics science and technology, uses and effects of nuclear energy, and weapon systems. It appears, however, that these topics are largely descriptive and relate to the technical employment of weapons, rather than to the sort of analytical approach that Admiral Hill had in mind in 1946.

The Army War College curriculum places heavy emphasis on technology as it relates to the functions and operations of the Army, and also to the Army's research and development programs. The part that deals with the Army opens with an orientation course in which about a third of the lectures deal with the impact of technological developments. The lectures treat such topcis as the effect of current and propected nuclear and conventional weapons on Army strategic, tactical, and logistic concepts, the role of military power in the era of mass destruction, the Army's research and development program, and combat developments and operations research. The course concludes with a panel discussion of the effect of nuclear warfare upon ground forces.

In subsequent courses the impact of new developments is considered. In the course on logistics, for example, there are lectures on the vulnerability of theater logistic operations in atomic warfare, and on the impact of atomic warfare on medical services. One of the committee problems deals with the impact of atomic and chemical warfare upon theater logistic operations. The first week of the course on Army operations is devoted to special instruction in technical developments affecting the conduct of future warfare, presented by teams from the Armed Forces special weapons program and other special projects, and from the Office of the Chief Chemical Officer, and by an engineer from a leading aircraft manufacturing company. The course includes several lectures dealing with weapons developments, and a committee study on the impact of new weapons on land warfare. The war planning courses also get into this field, particularly in the presentations by teams from the Naval and Air War Colleges on concepts of future warfare.

Although technological developments are scarcely ever absent from discussion of plans for the employment of armed forces, the Naval and Air War Colleges do not single out this field for such extensive treatment as does the Army War College. At Newport students in naval warfare I and II take a 4-day orientation course on nuclear weapons, covering the capabilities and limitations of available and projected weapons, employment techniques, and passive defense measures. Naval warfare I considers the latest weapons developments in the Army and Air Force as well as the Navy. Naval warfare II includes no other separate treatment of the scientific factor in strategic planning. The Air War College devotes considerably less attention to scientific research and devolpment as such than one might expect of a service in which this field is of primary significance. During the first years at the college there was a separate course on technology as applied to military operations. This is no longer given, and its subject matter is integrated into other courses.

This brief review indicates that the students at all of the senior colleges are exposed to a great deal of information on technological developments in the weapons field. They are given considerable information that would be of great value to the strategic planner as well as the commander in the field employing these new weapons. They consider the impact of such developments upon tactical

and strategic concepts and doctrines. At each of the colleges the faculty is responsible for obtaining current information on research and development projects in the services. At the Naval War College a small section of the staff is designated for this specific purpose. It should also be pointed out that at all of the colleges, and particularly the Air War College, many of the students have had specific training and assignments in the development field. But except for the Army War College, the colleges do not study the specific role of research and development, or the broader implications of technological change as they bear upon strategic planning.

Vannevar Bush, more than any other individual, has been concerned about the relationship of the scientist and the soldier. At one time he recommended that the idea of the National War College should be extended to include "an advanced military college devoted to the evolution of weapons and its relation to strategy." We do not agree with the notion of a separate school. But we do suggest that a somewhat different approach to consideration of science and technology at the existing schools might be made. We feel that some sacrifice could be made in the detailed study of weapons developments in order to give greater attention to broader aspects of the relationship of research and development to national security problems and plans. Particularly we see need for examination of the delicate question of the relationship of the professional military officer to the scientist and to theoretical research. While officers should have more knowledge of scientific principles and developments, they must recognize their own limitations and the expert role of the civilian scientist. The objective here is a relationship wherein the officer, as the expert on military applications, can communicate his needs to the scientist and in return can adjust with flexibility to new scientific developments. We question whether sufficient attention is given to this relationship at the colleges. We note, for example, that the special board established by the Joint Chiefs in 1954 to survey the National War College and the Industrial College concluded that more emphasis at these schools should be placed upon scientific and technological factors—Soldiers and Scholars, John W. Masland and Laurence I. Radway, pages 383–387.

LETTER TO CHAIRMAN DAWSON FROM MR. FRANK D. NEWBURY, FIRST ASSISTANT SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

MAY 16, 1958.

Hon. WILLIAM L. DAWSON,
Chairman, Committee on Government Operations,
House of Representatives, Washington, D. C.

DEAR MR. DAWSON: I welcome the opportunity provided by your letter of May 5, 1958, to give your committee my suggestions on certain aspects of research and development in the Department of Defense. I will limit my remarks to matters with which I had experience as an Assistant Secretary of Defense for Engineering—the time from August 1953 to May 1957—and, particularly, the organization and management of research and development activities within the Office of the Secretary of Defense.

I wish to say first that I strongly support the research and development provisions in the recent President's message on defense reorganization and in the proposed legislation recommended by the Secretary of Defense now being considered by the House Armed Services Committee.

My experience in the review of military department development programs, as an Assistant Secretary of Defense, convinced me that the Secretary of Defense should have more clear-cut and direct authority for the review and approval of research and development programs. I am convinced he should have in his office, under his direct supervision and control, technical staffs competent to review and assess the research and development programs of the military departments. Only by the work of the responsible Assistant Secretaries of Defense, and principally by the Assistant Secretary of Defense (Research and Engineering), or the proposed Director of Defense Research and Engineering, can the Secretary obtain the necessary objective evaluation of research programs and development programs to insure a well-balanced combined military program and the elimination of unnecessary, or other unjustifiable programs. Furthermore, there should be specific delegation of this authority and responsibility for the technical review and approval (or disapproval) of military programs by the Secretary of Defense to his Assistant Secretaries.

In my own experience, Secretary Wilson did specifically delegate this review and approval authority to my office for a major part of the development field, but this authority was denied and opposed principally by one of the military departments, and my activities were impeded by the refusal by the military departments to furnish pertinent information about individual development projects. In that and other ways the work of reviewing and approving programs was delayed.

I have a strong feeling that the Secretary of Defense needs the new legislation he has requested, at least in this field in which I have had some frustrating experience. However, legislation is not the only field in which changes and improvements in the administration of research and development programs are needed. A new law is not the complete answer. Changes in organization and administration of research and development activities are also needed, and especially in the evaluation of programs to obtain new weapons and equipment more rapidly, and for less cost.

It is evident that Secretary McElroy is aware of this management requirement. The changes he has already introduced in Defense organization and administration attest his understanding and his intention of meeting the need. I have in mind, in addition to the new legislation, Secretary McElroy's memorandum of May 1, 1958, on the subject of committees. By this memorandum he has abolished many committees, including those that have been established to perform operational, administrative, or management responsibilities; and, also, committees that have been established for the primary purpose of facilitating coordination of defense activities. Among the latter are the coordinating committees which have been used ever since the time of the former Research and Development Board to review and evaluate the research and development programs of the military departments.

Although the Secretary of Defense has directed the abolition of these coordinating committees, their actual death will not be easily accomplished. They have been a part of Defense Department organization and procedure since the establishment of the Department by the National Security Act of 1947; the committees have been strongly supported by the military departments for reasons I will discuss later on; and the technical staffs of the Office of the Secretary of Defense have had very little experience with any method of operation, other than by committees.

In view of this situation, and because the reasons for Secretary McElroy's action in abolishing these committees may not be understood, it may be worthwhile to discuss the background of coordinating committee history and the reasons for their failure to effectively review and evaluate research and development programs.

A BRIEF HISTORY OF COORDINATING COMMITTEES

The National Security Act of 1947 and its revision in 1949, created the Department of Defense, and created two boards, the Research and Development Board and the Munitions Board. Broadly, the Research and Development Board was responsible for the coordination of research and development activities up to the point of the availability and approval of new types of equipment for service use. The Munitions Board, among other duties, was responsible for the procurement, production, and supply of equipment for service use and for inventory stocks.

Although the act provided that the two boards were "subject to the authority of the Secretary of Defense," the Boards operated, largely, as independent agencies. Partly because of this attempted independence and, more importantly, because of a complicated committee structure, lack of prompt action even when the Chairman of the Board had the necessary powers, and opposition and lack of cooperation by the military departments, the Research and Development Board never realized the hopes of its sponsors.

Near the end of its career in 1953 the Research and Development Board had over 100 active committees, panels, and working groups, on which over 2,000 names were listed. The full-time staff of the Board consisted of 260 civilians and 16 military personnel and over 350 part-time consultants.

Under the complicated and rigid committee structure of the Research and Development Board, and the opposition of the military departments, effective coordination of military department development programs and the elimination of nnnecessary development projects proved to be well-nigh impossible.

The military departments dominated the committees of the Board. The military representatives on committees, panels, and working groups were expected to sit in judgment and act independently on projects previously approved by their departments. This objectivity is not possible in a military organization; and programs and projects submitted to the Research and Development Board committees for review were seldom disapproved. Controversial projects were usually delayed or never acted on. When a new Secretary of Defense came into office in 1953, the Research and Development Board and the Munitions Board had been discredited by their records and were on the way out.

THE ASSISTANT SECURITIES OF DEFENSE, 1953–57

In February 1953 a committee was appointed by Secretary Wilson to review the organization of the Department of Defense and to make recommendations: The Rockefeller Committee. The report of this committee was approved and became effective June 30, 1953, as Organization Plan No. 6.

Among other major changes in Defense Department organization the plan abolished the Research and Development Board and the Munitions Board and substituted additional Assistant Secretaries of Defense to take over their duties.

Under Organization Plan No. 6 an Assistant Secretary of Defense for Research and Development took over the major part of the functions, organization structure, and personnel of the superseded Research and Development Board. The plan also provided an Assistant Secretary of Defense (Applications Engineering).[1] Organization Plan No. 6 did not clearly define the review responsibilities of these 2 Offices and this confusion continued, in some measure, until the 2 Offices were consolidated during the spring of 1957 into 1 Office of Research and Engineering.

From June 1955 until the time the two Offices were consolidated the following division of responsibility for the review, coordination, and approval (or disapproval) of research and development programs and projects was established by the Secretary of Defense:

Part 1: Responsibility for the review and approval of all research programs and projects rested with the Assistant Secretary of Defense (Research and Development).

Part 2: The review and approval of development programs and individual projects funded by Research and Development appropriations was the joint responsibility of the two Assistant Secretaries of Defense (for Research and Development and for Engineering).

Part 3: The review and approval of development programs and individual projects funded by procurement and production appropriations was the sole responsibility of the Assistant Secretary of Defense (Engineering).

This division of responsibilities was by no means ideal but it was the best arrangement on which agreement could be reached at the time, and was far better than previous arrangements. It was not until the above arrangement was established in June 1955 that the major part of the military development program (pt. 3 above) that was funded by procurement and production appropriations amounting to several billion dollars was officially recognized and subjected to technical review by either the Assistant Secretary of Defense (Research and Development) or by the Assistant Secretary of Defense (Engineering).

The two Assistant Secretaries followed different policies and established different procedures for carrying out their review responsibilities.

It was stated that when the new Office of Assistant Secretary of Defense (Research and Development) was organized in 1953, this Office took over the structure and personnel of the superseded Research and Development Board, and an important part of this Research and Development Board organization structure was the structure of coordinating committees of the Board. The policy of the military representation on the review committees was continued in spite of this inherent organizational defect.

In the first two parts of review responsibility, listed above, for which the Assistant Secretary of Defense (Research and Development) was either solely or jointly responsible, the Research and Development Office took the lead and the coordinating committee procedure, with military representatives on the committees, was employed.

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[1] The title of this Office was changed later to Assistant Secretary of Defense (Engineering).

In connection with part 3 of this review responsibility for which the Assistant Secretary of Defense (Engineering) was solely responsible a new procedure was worked out in cooperation and agreement with the military departments. In this procedure there were no committees and no voting by military department representatives. Action was entirely within and by the staff of the Assistant Secretary of Defense (Engineering) and of other interested Assistant Secretaries of Defense.

When the two offices were consolidated into the one Office of Research and Engineering, there was no further need to distinguish between development projects funded by research and development appropriations, and development projects funded by procurement and production appropriations, and one review procedure could be adopted. Unfortunately, in my opinion, the wrong decision was made by adopting the coordinating committee procedure. Now Secretary McElroy has reversed this decision of a year ago by abolishing the coordinating committees.

In his memorandum of May 1, 1958, he states:

"While the need for effective coordination is fully recognized, it is believed that this objective can be attained through the establishment of less formal working relationships. In other words, it should not be necessary to charter a committee with responsibilities, functions, and duties in order to confer jointly on matters of mutual interest."

The relative success of the review activities of the Office of the Assistant Secretary of Defense (Engineering) from June 1955 to the early part of 1957 supports Secretary McElroy's statement.

RESEARCH AND DEVELOPMENT APPROPRIATIONS

Another major area in the administration of research and development programs where improvement is needed, is in the structure of research and development appropriations and in records of research and development expenditures.

It has been the practice for a number of years to provide research and development funds in an appropriation labeled "Research and Development" and in the much larger "Procurement and Production" appropriations.

At the congressional hearings on the fiscal year 1957 budget this distribution of research and development funds was presented to the House committee for the fiscal years 1955, 1956, and 1957, and as estimated, at that time, for fiscal year 1958:

[Millions of dollars]

	Fiscal year 1955	Fiscal year 1956	Fiscal year 1957	Fiscal year 1958, estimated
Included in research and development appropriations	$1,221	$1,493	$1,747	$1,701
Included in procurement and production appropriations	1,826	1,830	2,804	3,068

This budget practice has a number of disadvantages:

1. It has led to considerable misinformation as to the actual amount of Federal expenditures for research and development. In much of the published information, the large expenditures for development, buried in procurement and production figures, are omitted.

2. It is impossible to know, except by rough estimates, the amount of expenditures for research or for development.

3. More seriously, from the standpoint of administration, it has been difficult, if not impossible, to control the use of total funds and to maintain a proper balance between expenditures for basic and applied research, on the one hand, and for "hardware" development, on the other hand.

The correction of this situation requires a change in budget and appropriation practice to the end that basic and applied research activity, appropriations, and expenditures can be separated from the corresponding activities, appropriations, and expenditures of "hardware" development. This is necessary to protect research activity.

To accomplish this, it is necessary to clearly define these two kinds of activity in some such way as the following:

1. Basic and applied research includes all programs and individual projects whose objective is the increase of knowledge for general application.

2. Development covers the development of all service-type weapons and equipment, and includes the production and test of test units up to the time of approval of the weapon or equipment for production for service use or inventory. Consequently, a development program or project is one whose objective is development of equipment for service use.

It will be noted that these definitions, based on objective or purpose, are clear cut, are practical, and are mutually exclusive.

Basis-research activity cannot be easily separated from applied-research activity, but this is not necessary for effective administration of research activity. Consequently, a single set of appropriations and expenditure records can be used for the entire research activity of each military department. Each research appropriation should be used exclusively for basic and applied research as just defined.

When we consider development activity, it could be argued that there should be a separate set of appropriations for development, as just defined, and for procurement of weapons and equipment intended for service use. But this plan would require 3 sets of appropriations where we now have only 2. Also, there are good reasons for combining appropriations for development and for procurement. In many cases, there is no clear-cut transition from the production of units for engineering tests and to production of units of more advanced design that will be used for field testing. Also, in many cases, both development and initial production are included in a single development-production contract. Consequently, it is administratively desirable to have a single set of appropriations—"Development and procurement" appropriations—to cover both development and procurement. There should be an added provision of a coding system whereby separate records of development expenditures and procurement expenditures could be maintained.

Under existing practice, a large part of applied research, possibly 80 percent, is actually carried on as part of development contracts or development-production contracts. This practice results in necessarily small steps in applied research and in slow progress because of the contractor's responsibility for service-type performance within a specified delivery date, and at excessive cost under production factor conditions.

Under the proposed plan, the greater part of applied research would be carried on independently and in advance of development contract responsibility. Only a minimum of unforeseen applied research should be carried on as part of a development project and contract.

Sincerely yours,

FRANK D. NEWBURY.

Chairman DAWSON. Thank you so much, gentlemen.

(Whereupon, at 12 o'clock noon, the hearing in the above-entitled matter adjourned.)

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